Cleaner Greener Production Programme Phase 4 (CGPP4)

Final Report

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Iameco 2 - Low Carbon, Resource Efficiency and Long Life in PC Design

Multimedia Computer Systems Ltd (MicroPro)

Anne Galligan, Paul Maher, Directors
Jose Ospina, Project Manager

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98 Nutgrove Avenue, Rathfarnham, Dublin 14
Tel. 01 493 0514, Fax 01 494 3885
E-mail: agalligan@micropro.ie

Summary

The **iameco2 Project**[i] , funded by the EPA's Cleaner Greener Production Programme (CGPP), builds on research and development carried out by MicroPro with the support of a previous CGPP Project, the **ZWPC (Zero Waste Personal Computer) Project** [ii]. This earlier initiative aimed to design and manufacture a first prototype computer that would meet stringent, pre-defined ecological criteria. This first attempt was completed in 2005, and the resulting prototype, the **iameco v1,** was environmentally superior to conventional desktop computers. However, an Eco-Label could not be secured at this stage, and so the model was not widely marketed, remaining at prototype stage. MicroPro felt that further research and development was needed to the model before it was ready for wide-scale commercialisation.

In 2008 MicroPro presented the current **iameco2 Project** for consideration to EPA, requesting follow-up funding under the same CGPP. This new initiative aimed to carry out further research on the design of the prototype**,** integrating feedback from various quarters, as well as taking into account changes in the Eco-Label standard, and the recommendations of the new Eco-Design of Energy Using Products (EuP) Directive, in order to produce a more advanced and marketable prototype.

As a first step in this Project, beginning in March 2009, MicroPro developed a revised **iameco v2** prototype that was completed in December 2009. It was then transferred to the University of Limerick Department of Electronic and Computer Engineering (UL ECE) who carried out an initial evaluation and checked it for Energy Star 5 compliance, reporting back in April 2010[iii]. It was then transferred to Fraunhofer IZM (Berlin), who carried out a streamlined Life-Cycle Assessment (LCA[iv]), and then to Tricom, a specialist computer reuse enterprise in Berlin, who carried out a Disassembly evaluation of the model[v]. Both resulting reports were integrated (in July 2010) into a final Eco-Design Report by UL ECE, which included a series of practical design recommendations[vi].

On the basis of these recommendations, taking into account additional eco-design considerations proposed by Consultants, the **iameco v3,** was manufactured by MicroPro. This prototype was again tested for Energy Star 5 compliance (by UL ECE) and tested and certified for CE accreditation and European Eco-Label compliance, by three previously identified accredited laboratories, in Holland, Germany and Taiwan. The results were submitted to the National Standards Authority of Ireland (NSAI) in December 2010 for accreditation of the prototype under the European Eco-Label.

The evaluation process found the **iameco v3** to be compliant on most items, bar one exception: the electro-magnetic emission (EMC) levels of the display screen were found to be below the threshold specified by the Eco-Label. The accreditation process had therefore to be temporarily suspended in December 2010, and in April 2011 we identified a new and compliant display screen in Taiwan. The details of the new screen were then submitted to NSAI, together with all outstanding information, and the **iamecov3** was awarded the **World's First Eco-Label for Class B computers** (for mid range computers covering all office and home computers)on 19th May 2011.

The design of the iameco v3 ensures **resource efficiency** by reducing the use of materials and by smarter design.

The principal achievement of the Project has been the design and manufacture of a genuinely ecological desktop computer that meets a number of key benchmarks:

- CE compliance
- Energy Star 5
- Lots 3 and 5 of the Eco Design of Energy Using Products (EuP) Directive
- Design for Disassembly
- Design for Reuse
- European Eco-Label compliance

iameco v3

Key Environmental Performance Indicators (KEPI) set out originally by the **iameco2 Project** were as follows:

- 75% reduction in CO_2 emissions
- 75% reduction in fresh water use
- 98% of materials recyclable (by weight)
- 20% materials reusable (by weight)
- Hazardous materials eliminated
- Non-recyclable plastics eliminated
- 2 W or less energy consumption in Sleep State (for PC)
- No energy consumption in Sleep Mode (for PC and Monitor)
- Life extension to 10 years demonstrated
- All working parts accessible, upgradable, reusable
- Disassembly time reduced to 10 minutes or less
- Noise level no more than 25DB in operating mode and 35 DB when accessing disc drive
- Electro-magnetic emissions no more than 259 GHz
- Packaging 100% recyclable
- Comprehensive user Information provided
- Guaranteed take back for reuse offered.

All the above indicators were exceeded or complied with in relation to the prototype's performance as illustrated in detail in this report.

MicroPro has also carried out preliminary projections of the likely national and international market for the product and is confident of its viability and export potential. **iameco** will be fully manufactured and assembled in Ireland.

2. Background - Aim and General Description

2.1 Participant Description

MicroPro was formed in 1991, inspired by a strong environmental ethos. The company is based in Rathfarnham, Dublin, and is an Irish-owned Small Enterprise [vii] . MicroPro retails all major computer brands, as well as designing and manufacturing its own computer systems, software packages, networking systems and peripherals. The company also provide a repair, maintenance and upgrading service, and have a strong local and national client base. MicroPro Computers is the Official Toshiba Repair Centre and Certified Epson Report Centre for all their warranty repairs in Ireland.

MicroPro has been designing and manufacturing long life, updateable, upgradeable, reusable, recyclable computers since 1998. Under an Environmentally Superior Products (ESP) Programme EI commissioned a Feasibility Study into the environmental, technical, legal, marketing and financial implications of producing an ecological computer. This Project led to the manufacture of the **MicroPro Xpc**, the company's first eco-computer, already demonstrating better environmental performance than other conventional brands, according to the study resulting from this project. [viii].

In 2003 MicroPro became a Partner in **Project HEATSUN** (LIFE00/ENV/IRL/000764), a European Partnership Project, led by Dublin City Council, which investigated multiple aspects of electronic waste management. MicroPro's role in this Project was to develop an ecological computer that met the requirements of the European Eco-Label.

MicroPro also secured support from the EPA's CGPP to carry out Research and Development on this project and develop a more advanced ecological computer. The Project was entitled **Zero Waste Personal Computer (ZWPC)**[ix] and research support was provided by UL ECE. In addition, the KERP Centre for Excellence in Electronic Recycling in Vienna provided expert consultancy. The ZWPC project ended in 2005, and its recommendations resulted in the manufacture of the **iameco v1** prototype, which was launched at the European Commission during Environment Week in Brussels in June 2007.

iameco v1

2.2 Aim of the Project

The **iameco2 Project** aims to build on, and consolidate, the projects carried out to date, by developing a marketable model that secures the **European Eco-Label**, at the same time as improving on these standards by incorporating additional key environmental criteria. These include the recommendations of the **Eco-Design of Energy Using Products (EuP) Directive** (Lots 3 and 6).

Additional Eco-design approaches have also been proposed and integrated by Consultants, including **Design for Reuse (DfR)** and **Design for Disassembly (DfD)**. The Project also has endeavoured to identify and reduce the carbon footprint of the product and to reduce the use of fresh water in manufacture. Key Environmental Performance Indicators (KEPI) set out originally by the **iameco2 Project** were as follows:

- 75% reduction in CO_2 emissions
- 75% reduction in fresh water use
- 98% of materials recyclable (by weight)
- 20% materials reusable (by weight)
- Hazardous materials eliminated
- Non-recyclable plastics eliminated
- 2 W or less energy consumption in Sleep State (for PC)
- No energy consumption in Sleep Mode (for PC and Monitor)
- Life extension to 10 years demonstrated
- All working parts accessible, upgradable, reusable
- Disassembly time reduced to 10 minutes or less
- Noise level no more than 25DB in operating mode and 35 DB when accessing disc drive
- Electro-magnetic emissions no more than 259 GHz
- Packaging 100% recyclable
- Comprehensive user Information provided
- Guaranteed take back for reuse offered

All the above indicators were exceeded or complied with in relation to the prototype's performance as documented below.

3. Project Implementation

3.1 Investigation of Prevention Opportunities

3.1.1 Strategy to identify prevention opportunities

MicroPro's strategy to identify prevention opportunities, and to meet the objectives of the Project has been guided by selected European and international standards for environmental performance in computers (i.e. Energy Star 5, the European Eco-Label and the EuP – Lots 3 and 6), as well as by the integration of additional eco-design criteria identified by research.

These additional environmental criteria included:

- Selection of compliant peripherals and components
- Reduction in use of materials
- Integration of renewable and recycled materials
- Reduction of parts

- Design for Reuse (DfR)
- Design for Disassembly (DfD)

Some of these considerations are already implicit in the Standards used as benchmarks.

MicroPro also identified three key environmental objectives at the start of the Project:

- Combating climate change and reduce dependency on fossil fuels

Implementing the recommendation of the EUP Directive, by reducing energy use in Stand By and Off modes and by carrying out an LCA of the prototype in terms of its CO_2 footprint.

- Reducing proliferation and obsolescence of IT equipment

Implementing Design for Reuse. Design for Disassembly was also important to ensure that Life Extension of 10 years was achieved. This required the putting in place of service arrangements that would allow the product to be upgraded and taken back for reuse. It required the development of a Product/Service Strategy for the **iameco.**

- Promoting resource efficiency and sustainability

Substituting the non-recyclable and hard to recycle materials used in conventional computer design, with renewable and recyclable materials. Also simplifying the design to use less material and have fewer parts. Also by eliminating or reducing hazardous and toxic substances beyond the level required by the Eco-Label and other Directives.

MicroPro knows from previous research that the major environmental benefits depended on the implementation of the DfR approach, that is the extension of the life of the product through upgrading and reuse of whole equipment or parts and components. "Smart" selection of materials and components for the original prototype, that is selection with a view to both performance and durability, was important. But the benefits of this would only be achieved by the implementation of reuse.

MicroPro's conclusions mirror the Xerox Company's concept of a "reuse as a manufacturing strategy". In the early 90's, Xerox made this approach central not only to the design and marketing of their office equipment, but also to their entire business strategy. This is documented in Adam Werbach's book, **Strategy for Sustainability: A Business Manifesto**[x]**.** In it he recounts how Xerox from 1993 onwards, transformed itself from a loss making concern into a thriving success story on the basis of comprehensive integration of this strategy. They called it their North Star Goal, and defined it as:

"The production of waste-free products in waste-free facilities, to provide waste free offices for customers".

Focus on this North Star had the effect of:

- Reducing costs in the long term, allowing savings that increase profits over the extended product life
- Eliminating waste and reducing the cost and negative environmental and social impact of waste
- Developing the ethical image of the company to clients, stakeholders and the public.

This reuse strategy is relevant to MicroPro, promoting the following paradigm shifts:

- **from Products to Services (Product/Service Strategy).** This implies moving away from the conventional sale of a product, to sale of an upgradable product with the possibility of accessible upgrade services and guaranteed take back for reuse.

- **from industrial design, to design with re-manufacturing in mind**. This means being able to take a used machine and renewing it so that it operates as a new machine. This implies materials, parts and components have to be selected with a view to durability and universality. This concept implies being able to test the parameters of useful parts and components so as to be able to guarantee extended optimal operation.

- **to avoiding the down-cycling of parts or components**, until all possibilities of reuse in its present state are exhausted. The design must be simplified and the number of working parts in the computer reduced.

- **to setting standards for the quality of reused parts and components**. Xerox pioneered the development of the **ISO 24700** "Standard for Qualified Performance of Office Equipment with Reused Parts". This standard aims to confirm to customers that a remanufactured product meets basic quality criteria. MicroPro will develop equivalent standards in its equipment using reused parts.

- **to develop universality in design**. The housing and chassis must be designed, and parts and components selected so that the same parts can be used in different models. MicroPro is aiming for universality in the design and connections in the housing, and in other parts and components.

- **to work from a Life Cycle Cost Assessment is needed** to establish the full economic benefits of this mode of design manufacture and re-manufacture. This must cost the process over the life of the parts and components, not just in its initial investment. The initial investment could be high, but subsequent product lives – that is upgrading or remanufacture of the prototype so the entire computer system or its constituent materials/components can be purchased again by another consumer for a second useful life or for another purpose entirely (e.g. whole machine reused as cash register, reuse of LCDs in advertisement panels, reuse of wooden frame as picture frame). The reuse strategy will generate further savings that will more than repay the initial investment.

- **to design for reuse, design for disassembly and design for durability are required**, both of the entire appliance and its parts and components. Easy access to working parts, use of snap on fasteners, only basic tools required for disassembly without damage, and speed of disassembly, facilitates upgrading and extends the product life.

- **to reduce energy use, both embedded energy, energy in production and in use**, is another key goal, which has both cost and environmental benefits.

- **to maximise the used materials from sustainable sources** is another consideration. The computer housing is manufactured from FSC certified wood from sustainable forests. Also use of recycled stainless steel/aluminium for the PC housing.

Apart from the environmental gains, this strategy should result in long-term cost-effectiveness. Xerox believe that they have saved hundreds of millions of dollars through their Reuse Strategy. They turned waste in to raw materials that are already processed. MicroPro is only now setting out this strategy, but initial estimates indicate that results could be similarly positive.

3.1.2 Knowledge of company operations

The **Iameco 2 Project** has resulted in increased knowledge and understanding of Eco-design for MicroPro. The **iameco v3** prototype embodies principles that are not usually taken into account by conventional computer manufacturers. This is evident in the low level of reuse of computers, of reuse of parts and components, and in the high level of computer waste evident everywhere.

The MicroPro eco-design approach involves simplifying design, reducing the number of parts, improving access to working parts and facilitating disassembly. Parts and components are selected to be compliant with stringent technical specifications, but they are also selected for robustness and durability.

The unique selling point (USP) of the **iameco v3** is embodiment of the eco-design principles of life-extension, reuse and upgradability. MicroPro can maximise the environmental potential of its parts and computers, eliminating the need for periodic disposal and replacement. Most companies currently replace their computers with new ones every 3 or 4 years. No other computer manufacturer is, to our knowledge, currently designing to implement an extended-life and reuse approach.

3.1.3 Prioritised improvement options.

The baseline for comparison and starting point for the **iameco2 Project** was the already environmentally superior **iamecoV1** prototype. This was challenging (possibly too challenging) as this prototype had previously been found to be around 25% more efficient in terms of energy consumption at all stages and recyclability and reusability, to the **MicroPro Xpc.** This in turn had already been identified as superior to conventional PC's.

In their Final Report, for the ZWPC Project, KERP said of the **iameco v1:**
"The improvements (in comparison with **the MicroPro Xpc**) concentrate on the usage stage and consider strategies for a longer time of usage and better recycling performance. The **iameco** is larger than the Xpc and because of this, the improvement in environmental impact in the life cycle phases of raw material extraction and production could not show a significant improvement. But by focusing on a longer usage time the potential for improved ecological performance in all life cycle phases can be achieved. However a precondition for this is consumer acceptance and action (i.e. willingness to upgrade rather than buying a complete new PC).[xi]

From this already high baseline, MicroPro set out to design and manufacture a third prototype that would be significantly better. The **iameco v2** prototype was completed in December 2009, and then evaluated by expert external agencies appointed by MicroPro. This evaluation included:

a) Energy Star 5 compliance (by UL ECE)
b) Life Cycle Assessment (by Fraunhofer IZM in Berlin[xii])
c) Disassembly and Reusability (Tricom in Berlin)[xiii]

The recommendations of these expert agencies were integrated into the **iameco2 Eco-Design Report**[xivxv]. This report spells out the various design recommendations arising from this analysis as follows:-

1) Prototype should be designed as an Integrated Desktop - Category B system under Energy Star 5
2) The Power Supply should be Energy Star 5 compliant
3) The display selected should use LED backlighting which contains no mercury
4) The desktop should contain no toxic flame retardants as specified in relevant Directives
5) Spare parts for the desktop should be available for at least 5 years after production
6) Life time of the desktop should be extended by having an upgradable memory, expansion capability and at least 2 USB interfaces
7) Detailed user-instructions should be provided with the PC.
8) Packaging should be made of at least 80% recyclable materials
9) PC should be fully Energy Star 5 compliant
10) The declared A weighted sound Power Level should not exceed 40 dB (A) in idle operating mode and 45 dB when accessing a hard disc drive
11) The display should meet the current maximum exposure limits set out in EU Council recommendation 1999/519/EC on limitation of exposure to electromagnetic fields.
12) The Eco-label on the PC should specify that it is energy efficient and has mercury free backlights
13) The power consumption of the PC in off-mode should not exceed 1.0 W
14) The design must conform to strict disassembly and lifetime extension criteria specified.

3.1.4 Implemented improvements

The **iameco v2** was also designed to achieve a high standard of technical performance and attractive multifunctional design. This is evident in its specifications:

- integrated, multi-touch, fan less, solid state silent computer (less than 22db noise level),
- Intel dual core D510 processor,
- SSD hard drive,
- SATA (Serial Advanced Technology Attachments) [xvi]drives can also be used.
- up to 4GB Ram, card reader, webcam, microphone,
- Intel motherboard,
- multi-touch screen LED display,
- wireless, LAN,
- 2 serial, 1 parallel, 4 USBs,
- VGA out, stereo speakers, audio out,
- VESA mount and a 3 year warranty.

By eliminating mechanical drives reliability is increased and noise and heat levels were reduced. The keyboard, mouse and PC box were all integrated as a single unit. The screen had a touch control virtual keyboard and mouse, saving on raw materials and energy. An external keyboard and mouse could also be used if required.

iameco v2

3.2 Changes in Practices or Processes

3.2.1 Outline description of the project –

Outline description of progress and results to date.

The **iameco 2 project** began in March 2009. The **iameco v2** prototype was completed in December 2009, and evaluated from then until May 2010 by UL ECE, the Fraunhofer IZM (Berlin) and Tricom (Berlin). The Fraunhofer Institute evaluation was primarily a simplified Life Cycle Analysis of the carbon footprint of the prototype.

As a result of these evaluations, a number of design recommendations were made [xvii] and on the basis of these recommendations a further prototype was designed and manufactured. The **iameco v3** was then tested for the Energy Star 5 compliance by UL ECE, and for all aspects of the European Eco-Label by qualified laboratories. The results were submitted to the National Standards Authority of Ireland (NSAI), for compliance with the Eco-Label. The **iameco v3** was found to be compliant on most items, except for one, the electro-magnetic emission levels of the screen, which did not meet the required Category A standard. In April 2011 a compliant screen was identified and the information submitted to NSAI.

The EU EcoLabel was officially awarded to MicroPro Computers on 19th May 2011 making iameco the World's First Class B Computer to receive the prestigious label.

The iameco 2 Project's Work Programme was divided into a number of Work Packages as follows:

Work Package 1 - Consolidate Environmental Standards for the Prototype

The principal objective of this WP has been to meet the higher standards of the Energy Star Version 5, as well as other items in the Eco-Label Criteria[xviii]. UL ECE was responsible for the overall evaluation of the prototype and testing for the Energy Star 5.

In April 2010 UL ECE reported on their methodology and results of these tests. They found the prototype compliant with the Energy Star standard, achieving a TEC of 105k Wh, when connected to a network and 134.29k Wh, when not connected to a network, both under the required threshold is <_175.0k Wh[xix].

Other aspects of compliance with the Eco-Label were considered by UL ECE, but no tests by accredited laboratories were carried out at this stage as they would only be carried out on the final prototype version. UL ECE also advised MicroPro regarding the specifications required by the different parts and components.

Work Package 2 - Combat Climate Change and reduce dependency on fossil fuels.

This WP aimed at achieving the requirements of the Eco-design of Energy Using Products (EuP) Directive. The final report for Personal Computers (Lot 3)[xx] and a further EC Regulation on Eco-design requirements for stand-by and off modes of electrical, electronic and office equipment (Lot 6)[xxi]. UL ECE carried out an evaluation of the **iameco v2** prototype with respect to the recommendations of these two EuP Reports from December 2009 to May 2010[xxii] .

A simplified Life Cycle Assessment of the **iameco v2** was carried out by the Fraunhofer IZM in Berlin, to establish the carbon footprint of the prototype and to make recommendations for its improvement[xxiii]. The **iameco v2** was then sent on to Tricom, an experienced computer reuse enterprise and part of the Reuse Computer Network in Berlin, for evaluation with respect to disassembly and reuse friendliness of the prototype.

The calculation of the carbon footprint by Fraunhofer IZM was based on the EuP methodology and is illustrated in the figure below. The use phase scenario was assumed to be 6 years. This assessment includes the display unit; life cycle data for wood (oak) material and wood disposal is derived from the SolidWorks assessment.

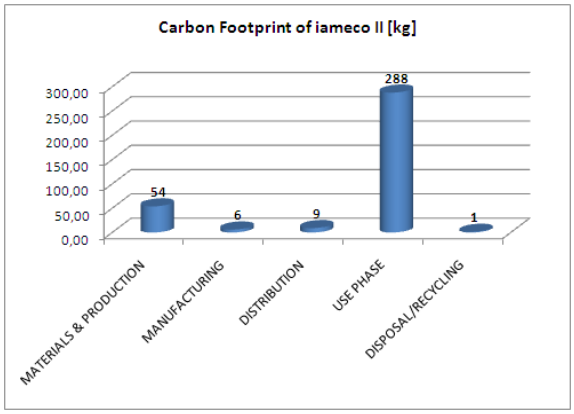

Figure 1: Carbon footprint based on EuP methodology

The total carbon footprint of the **iameco v2** prototype was calculated at 358 kg CO_2-eq., which is a particularly low result for computers. The use phase was confirmed as the most dominant burden in terms of this impact category. In terms of raw material extraction and production the display (27.7kg CO_2-eq.) is responsible for more than 50% of the greenhouse gas emissions. The second and third

important components were the motherboard and the metal housing parts respectively with the metal housing component contributing to more than 90% to the carbon footprint of the housing.

iameco v2 - bottom panel

The choice of wood, although interesting, does not make too much difference on the final result, looking at primary energy consumption and global warming potential only. Actually, compared with the **iameco v1** the change towards a wooden housing means a significant reduction of primary energy consumption. Nevertheless, the metal frame of the housing represents a major share of embedded energy content of all parts of the iameco v2. Looking at the carbon footprint the dominating part in production and manufacturing is the LCD display.

The Disassembly Report carried out by Tricom[xxiv] concluded:
"The SME controllable design changes discussed above have been implemented in IAMECO II (second prototype). Table 2 illustrates the results and shows that DfD has been considerably improved when compared to the first prototype. A considerable improvement has been made to the design which allows complete non-destructive disassembly of the system by a qualified technician. One qualified person alone shall be able to dismantle it."

Design Aspect	Rating	Rating	Comments
	IAMECO II (Prototype 1)	IAMECO II (Prototype 2)	
Accessibility			
Required Tools	☺ ☺ ☺ ☺ ☺	☺ ☺ ☺ ☺ ☺	Single Philips Screwdriver connections are accessible with commonly available tools.
Connection Elements	☺☺☺☺	☺☺☺☺	3 types of screw were still required in the second prototype. However these were all removable by the same Philips screwdriver connections are as standardised as possible
Replace-and extensionability			
Motherboard	☺☺☺	☺☺☺	N/A (Improvement not possible by SME)
Memory	☺☺☺☺☺	☺☺☺☺☺	N/A (Improvement not possible by SME)
Hard disk	☺☺☺☺☺	☺☺☺☺☺	N/A (Improvement not possible by SME)
Display	☺☺☺	☺☺☺	N/A (Improvement not possible by SME)
Extra components			N/A (Improvement not possible by SME)
Demountability			
Demountability criterion illustrates connections are easy to find and accessible	☺☺☺☺	☺☺☺☺	Screw count reduced from to 8 to 5 (not significant to warrant bonus point)
Case open	☺☺☺☺	☺☺☺☺	Screw count reduced from 8 to 5 (not significant to warrant bonus point)
CPU cooler demount	☺☺☺	☺☺☺☺	Screw count reduced from 14 to 8.
Hard disk demount	☺☺☺	☺☺☺☺	Screw count reduced from 14 to 5.
Memory demount	☺	☺☺☺	Motherboard demount was destructive disassembly in prototype 1. Through design change it was possible to achieve complete non destructive disassembly in prototype
Motherboard demount	☺☺☺☺	☺☺☺☺	N/A (Improvement not possible by SME)
Fan demount	☺☺☺☺	☺☺☺☺	Display demount was destructive disassembly in prototype 1. Through design change it was possible to achieve complete non destructive disassembly in prototype 2.
Display demount		☺☺☺☺	

Figure 2: iameco II (Prototype 2) DfD Assessment Results

WP 3 - Reduce proliferation and obsolescence

This WP aimed to integrate eco-design approaches to ensure that the potential for multiple functionality, aimed at avoiding obsolescence and unnecessary proliferation of equipment.

The **iameco v3** incorporates the principle of **multi-functionality,** aimed at reducing potential proliferation of equipment. This is achieved by equipping the PC with multiple plug- in facilities and a touch-screen design. This allows connectivity with various applications as modular attachments that can be added-on to the main equipment centre embedded in the screen housing. Multiple applications, such as voice over Internet, satellite TV, TV/radio tuner, internet radio, additional sound, microphone, MP3 etc, can be plugged into the central device, making it a multi-purpose communication and entertainment centre.

Obsolescence has been reduced primarily by Design for Disassembly (DfD). All components can be easily removed and upgraded, with no need to dispose of the PC. Obsolescence is also addressed in the prototype through the plug-in principle, which allows users to plug in additional peripherals, without difficulty. Ease of repair and upgrading, guarantee of availability of spare parts and services for upgrading and repair, also contribute to reducing in-built obsolescence.

The iameco v3 can be fully disassembled using one Philips screwdriver.

WP 4 - Resource Efficiency and Sustainability.

The design of the **iameco v3** ensures resource efficiency by reducing the use of materials and by smarter design. The size of the prototype has been reduced, and the number of working parts reduced. The ease of disassembly, upgrading and reuse greatly contributes to the economy of materials.

The use of renewable resources, such as wood for the housing, is a major step towards resource efficiency. The housing is made primarily from wood and some stainless steel for strength. The use of wood from FSC certified renewable forests, which is also carbon positive, greatly contributes to resource efficiency.

The fact that both the housing is designed and the parts and components are selected for reuse (DfR), is a principal factor in the life-extension, both of the product and of the parts and components. For this to be effective an upgrading and take-back service and infrastructure is required.

Other considerations include ensuring compliance by manufacturers of parts and components with the WEEE Directive and RoHS Directives (2002/95/EC and 2006/121/EC) that deal with hazardous materials. Use of PVC has also been eliminated. Use of plastics, lead, mercury, PVC's and other non-renewable and hazardous materials has been reduced or eliminated. The power supply is external to reduce heat, and ICE technology based on a copper pipe process is used for cooling.

WP 5 - Manufacture of the iameco Prototype.

Work on the manufacture of the **iameco v2** began in March 2009 and was completed in December 2009. Manufacture was carried out in Germany, and assembly in Ireland. The prototype incorporated the principal design proposals by MicroPro.

The **iameco v2** prototype was analysed and evaluated by UL ECE, and sent on to the other agencies, the Fraunhofer IZM and Tricom It was disassembled to basic components and analysed as part of a simplified Life Cycle Assessment (LCA). The analysed results indicated that this prototype would meet the ambitious environmental targets set out by the project.

MicroPro designed the **iameco v3,** taking these considerations into account and maintaining the integrated desktop PC format. The engineering was carried out in Germany by a MicroPro contractor, and two **iameco v3** prototypes were delivered to MicroPro in July 2010. One of the prototypes was shipped back to Germany for further design improvements (related to reducing the mass of the metal frame surrounding the display) , and the other was sent on for testing, to UL ECE, followed by shipment to accredited laboratories in Holland and Germany. The screen was tested in Taiwan, where it was manufactured.

Laboratories holding the necessary accreditations for testing for the Eco-Label were identified with the help of NSAI. The prototype was shipped to the laboratories selected for the required tests. The selected laboratories were:

- UL ECE (for Energy Star 5)
- BICOM (Holland) (for the CE tests)
- TUV Rhineland (Germany) (for the Noise Tests)
- TUV Rhineland (Taiwan) (for Electro Magnetic Emission test)

Once the tests were carried out and returned, an application was submitted to NSAI for Eco-Label accreditation.

The final test to be carried out, the EMC test on the display, carried out by TUV Rhineland (Taiwan) showed that the screen was not conforming with standard EN50279 for integrated desktop computers. The display screen, AUO screen model **AOU/B156XW02,** did not reach the required parameters as far as electromagnetic emissions required by the Eco-Label (Category A screen), as both Display Mode A and Display Mode B showed variations greater than permitted for Category A at 230 V / 50HZ. This reduced the Category rating to Category B.

In April 2011, contractors in Taiwan identified a new compliant screen that was substituted for the previous model. This was the **AUO/B156XWQ2.** This was tested by TUV Rhineland (Taiwan) on April 13th and found to have both Display Mode A and Display Mode B variations under the threshold required for Category A at 230V/50HZ. This new screen is therefore Category A compliant.

This additional information, together with outstanding information on other matters, was submitted to NSAI, who on May 18th 2011 gave verbal confirmation of the eligibility for Eco-Label accreditation for the **iameco v3** followed by official certification on 19th May 2011**.**

WP 6 - Effective Communication of the Environmental Message.

Various dissemination actions were undertaken during the project life. MicroPro has participated in the launch of an EPA report entitled *Innovation for a Green Economy - Environment and Technology: A win-win story.* This event was widely reported in the media.

Since May 2009 MicroPro has been Partner in a FP7 Project, ZeroWIN (Zero Waste Industrial Networks) Project (ENV.2008.3.1.3.1). This Project includes 30 beneficiaries from 10 countries, many of whom are electronic and computer related companies. MicroPro has made presentations of the characteristics and progress of the iameco prototypes, including the positive role of the EPA's CGPP programme in their development, at several of these events.

The **iameco v2** prototype was exhibited at the Vision Conference of the ZeroWIN Project at the University of Southampton on 06.07.10. This Conference was attended by over 120 representatives of international environmental and electronic companies, including UNIDO, the UK Environment Agency, GTZ, Hewlett Packard, BioRegional, Environ, Continental, AUO (Taiwan) as well as over 18 Universities and many research agencies. A presentation which described the work carried out in the **Iameco2 Project** was made by Dr. Stewart Hickey of UL ECE.

A further exhibition of the **iameco v3** took place at the Care Innovation Going Green Conference held in Vienna from 08 to 11.11.10. The prototype was displayed on the Fraunhofer IZM stand at this exhibition, and Dr. Stewart Hickey of UL ECE presented a paper entitled "Practical Eco-Design Approaches for Personal Computers – A Case Study of the iameco II". This paper gives a detailed description of the eco-design process leading up to the development of the **Iameco v3**[xxv].

José Ospina Development Consultant for MicroPro on the Project, has also co-authored chapter "ReDesign – Reaping the Benefits of Making the Recycler's Job Easier" (working title) for an upcoming book on e-waste issues, to be published by the StEP Initiative later in 2011. This paper features the iameco 2 case study prominently to showcase the achievements of a small enterprise in terms of a sustainable product design.

MicroPro are also Partners, since January 2011, in the FP7 funded Project LCA to Go: Boosting Life Cycle Assessment Use in European Small and Medium-sized Enterprises: Serving Needs of Innovative Key Sectors with Smart Methods and Tools.

LCA to Go develops sectoral methods and tools for bio-based plastics, industrial machinery, electronics, renewable energy, sensors and smart textiles. These sectors have been chosen, as the manufacturers show a high interest in making clear the environmental benefits of their products to customers (Green industries) and in prioritizing so they can reduce their environmental impacts. This is particularly the case for SMEs. Free webtools (apps) will serve dedicated needs of these sectors, addressing the specifics of the technologies and implementing parameterised models, such as calculators for energy-break-even-point of photovoltaics, Product Carbon Footprints (PCF) based on technology parameters of printed circuit boards, and Key Environmental Performance Indicators (KEPIs) for smart textiles. Selected Product Category Rules will be developed to provide a robust LCA guidance for SMEs. Practically, the project website will provide an exchange of scientifically validated data templates, to assist SMEs to ask the right questions to their suppliers.

Carbon Footprints are a perfect entry point for SMEs to LCA strategies. Thus, implementation of an SME-compatible PCF methodology is a key element of the project. The approaches will be tested in 7 sectoral case studies, involving suppliers, end-product manufacturers and engineering companies. Inter-linkages between the sectors (on a technical and data level) will be thoroughly addressed. A broad dissemination campaign includes a mentoring programme for 100 SMEs, which will act as showcases for others, boosting use of LCA approaches among European SMEs at large. RTD and dissemination activities will be complemented by policy recommendations and liaison with standardisation activities. The web-tools, being compatible with ILCD data and other external sources, will be made available as open source software, to be adapted to other sectors. The project will have a direct impact on sectors representing nearly 500,000 SMEs.

MicroPro and the **iameco v3** will be a Case Study for LCA within the Project. The **iameco2 Project** has already been presented to project partners, and MicroPro will also participate in dissemination of the Life-Cycle approach to other SME's.

MicroPro has developed a web page for the **iameco2 Project** linked to their company web site (www.micropro.ie), which will soon be in operation. MicroPro also intends to send out an electronic newsletter promoting the iameco v3 and explaining the results of the project. MicroPro has also improved the **iameco** logo and branding the new prototype.

A formal Launch of the iameco v3 has now been arranged for September 9th. The Launch ceremony will be carried out by Irish statesman and presidential candidate Michael D. Higgins as well as representatives of EPA and MicroPro.

3.2.2 *Project management*

Anne Galligan has been Project Manager and Paul Maher has been Technical Manager of the **iameco2 project.** MicroPro began work on the project in March 2009. Paul is a Director of MicroPro and is the designer and developer of environmentally friendly computers with 20 years engineering experience. Anne has been Manager of MicroPro since its inception, and has a background in banking and administration. The Company is accredited to EMS standard ISO 14001 and ISO 9001.

José Ospina was appointed Development Consultant to the Project in April 2009. Jose has worked as consultant to MicroPro on previous projects. He was also Project Manager for of Dublin City Council on Project HEATSUN .

University of Limerick Department of Electric and Electronic Engineering (UL ECE) was commissioned in November 2009 to co-ordinate the technical evaluation of the prototype and make recommendations for the design and manufacture of the prototype. A sub-contract was undertaken with Fraunhofer IZM to provide a simplified LCA on the carbon footprint of the prototype. Tricom, is a computer reuse enterprise in Berlin and a member of the Berlin Reuse Computer Networks, and agreed to participate in the Project by carrying out a disassembly and evaluation of the prototype.

The initial project proposal was varied with EPA consent to include the design and manufacture of the **iameco v2** as the first step of the Project, this prototype to be evaluated and re-designed, and manufactured as the **iameco v3**, which would be tested for compliance with the Eco-label. The **iameco v2** was developed for test purposes only. The methodology was an improvement to the original proposal, as there was considerable improvement between the **v2** to **v3** prototypes, on the basis of advice from the technical panel.

3.2.3 *Operating history*

The first Project team meeting of the project took place in November 2009 and the first liaison meeting with EPA took place in mid November 2009. The iameco v2 was finalised in December 2009 and evaluated by UL ECE, Fraunhofer and Tricom. Evaluation was complete by May 2010 and the iameco v3 prototype was finalised by July 2010. Tests for the Energy Star and Eco-Label were carried out from July to December in 2010. The screen was found to be non-compliant and testing suspended in December 2010.

During the Project there have been 17 minuted meetings of the staff team and external consultants (around one per month). The meetings, and subsequent minutes and action schedules allowed monitoring of progress, revision of the work programme, and troubleshooting of technical and administrative issues as required. Progress has been smooth, and the team meetings provide a basis for liaison and continuity within a complicated technical programme. Several liaison meetings were also held with the EPA desk officer, throughout the duration of the Project.

3.2.4 *Implementation experiences*

The initial analysis and evaluation of the **iameco v2** was carried out by UL ECE, and then the prototype was passed on to Fraunhofer IZM and Tricom. Analysis and evaluation resulted in a number of observations and changes to the initial prototype design which has been outlined above. In fact, the recommendations of the consolidated report contained 14 specific design changes, all of which were implemented within the life of the project.

Back cover of iameco v2

3.2.5 *Equipment performance*

In all required tests, the **iameco v3** and its parts and components tested positively with respect to compliance. This applies to all tests required for Energy Star 5, CE and Eco-Label compliance. The certified test results were all made available to the NSAI and are available from MicroPro.

In April 2011, contractors in Taiwan identified a new compliant screen that was substituted for the previous model. This was the **AUO/B156XWQ2.** This was tested by TUV Rhineland (Taiwan) on April 13th and found to have both Display Mode A and Display Mode B variations under the threshold required for Category A at 230V/50HZ. This new screen is therefore Category A compliant.

3.2.6 *Modifications*

The principal modifications to the submitted project were the decision to manufacture two prototypes, explained above. The project was extended by three months in order to allow for this additional design and manufacture, and then a further extension of one month was allowed at the end of the Project to allow the results of the Eco-Label tests to be returned and submitted to NSAI.

A final unexpected problem emerged in December 2010, in the non-compliance of the original **iameco v3** screen incorporated, with the electromagnetic (EME) parameters required by the Eco-Label. MicroPro was not aware of this short coming at the time of selecting the screen. In April 2011 a new and compliant screen was identified and tested and the results submitted to NSAI, who certified the EU EcoLabel on 19th May 2011.

3.2.7 *Measurement/monitoring procedures*

In October and November 2010, the **iameco v3** was sent to the selected accredited laboratories for the tests required for CE and European Eco-Label compliance:

I) **Energy Star 5 compliance:** This required various tests of energy consumption in use stand-by and off mode. This needs to be carried out by a competent agency with specialist measuring equipment. UL ECE is such a body.

II) **CE-label testing requires measurements according to the EMC en LV-directive and acoustic measurements.** These have to be carried out by a laboratory accredited to ISO17025:2005, for conducting the EMC measurements. The applicant (MicroPro) is obliged to provide the competent body (NSAI) with a report, showing that the equipment is compliant with this standard. This has been done.

III) **Electromagnetic emission tests**: Tests for the screen have to be carried out by a laboratory holding ISO17025 accreditation, and accredited to carry out EE tests in line with standard EN50279, Category A. The applicant (MicroPro) is obliged to provide the competent body (NSAI) with a report, showing that the monitor's emissions comply with this standard. This has been done.

IV) **Noise tests :** These were carried out by a laboratory accredited to ISO 17025 standard, certifying that the levels of noise have been measured in accordance with ISO 7779 and declared in accordance with ISO 9296. The report shall state that the measured levels of noise emissions in both the idle and operating mode and when accessing a disk drive, shall be declared in accordance with paragraph 3.2.5 of ISO 9296. This has been done.

UL ECE carried out the overall evaluating and the Energy Star 5 compliance tests. UL ECE did not require specific accreditation for this, although the test has to be carried out using equipment which is of a specified criteria and using a specified protocol. The accredited laboratories for the other tests were, BICON (Holland) and TUV (Germany) and TUV (Taiwan) all holding the necessary accreditation (ISO 17025) for these tests.

The tests were concluded by December 2010 and showed that the **iameco v3** was compliant with all required criteria, with the exception of the display. Certifications of all required tests are available from MicroPro.

3.3 Capacity Building

3.3.1 *Training of staff*

MicroPro proposed in the original Project, to develop its corporate skills in environmental management and Life Cycle Assessment practises, both in the design and manufacture of products and the provision of services. It was MicroPro's intention as part of this Project, to work with the University of Limerick in the design of tailor made training package for MicroPro staff, in the following areas

- Eco-design methodology
- EuP Directive and its implications to ICT
- Life Cycle Assessment and accreditation
- Revised ISO and EMAS Standards for Environmental Auditing

The purpose of this training was to ensure that the technical and methodological knowledge derived from the Project directly benefits MicroPro staff, building up its professional know-how. It was suggested that the course will have duration of 10 days per annum, and will lead to a Certificate in Computers and the Environment issued by the University.

It has not been possible for the Project to organise the formal training course initially proposed, as UL ECE was not able to either set up such a course or provide accredited training to MicroPro. As a result MicroPro had dropped the proposal of formal training for its staff from the Project.

In practise, training has been received by staff in all these areas, in terms of the practical recommendations and implementation of these were carried out during the Project.
In particular:

- Eco-design methodology

There has been comprehensive research and discussion into this area, carried out by external consultants and internally by MicroPro staff and consultants; to the extent that MicroPro believes its staff have a clear grasp of these principles.

- EuP Directive and its implications to ICT

MicroPro staff has participated in the testing of the prototype for compliance with the Energy Star 5 and are now able to carry out such tests in house. They have also integrated the recommendations of UL ECE and the Fraunhofer Institute with respect to the CO_2 footprint of the prototypes and the options that increase and reduce it.

- Life Cycle Assessment and accreditation:

MicroPro has learnt much from the simplified Life Cycle Assessment carried out by Fraunhofer IZM. In January 2011 it further progressed its work in this area by becoming a Partner in the LCA to Go Project (above) also led by the Fraunhofer Institute. MicroPro is participating in the development of Life Cycle Assessment software for small and medium sized enterprises, and will learn through the Project how to carry these out and train others in carrying LCA's out.

- ISO and EMAS Standards for Environmental Auditing

MicroPro staff has received further training in relation to its accreditation for ISO 9001 and ISO 14001.

I) **ISO 9001:2008** requires an organisation to identify its customer's needs. Frame the customer needs within its quality policy, define objectives to achieve enhanced customer satisfaction. Plan to achieve its objectives and meet requirements specified by the customer (during placing of an order or by other communication such as meetings, surveys, focus groups, etc.). Implement the plans and monitor and measure them for effectiveness. Analyse the data from the monitoring and measuring processes to provide management with factual information to change and improve the system to further enhance customer satisfaction.

II) **ISO 14001:2004** requires an organisation to identify its environmental aspects. Frame the aspects within its environmental policy; define objectives and targets to achieve an identified level of environmental performance, which at minimum focus on pollution prevention. Plan to achieve its objectives and target. Implement the plans and monitor and measure them for effectiveness. Analyse the data from the monitoring and measuring processes to provide management with factual information to change and improve the system to further enhance environmental performance.

As an additional and training output, MicroPro has been collaborating with the Marcel-Breuer Schule, vocational training centre in Berlin, in the development of a vocational training course for Wood Technicians (Holzmechaniker). The occupational status of Wood Technician (Holzmechaniker) is already accredited by the German Chamber for Industry.

As part of this centre-based training, the Marcel-Breuer Schule intends to carry out a practical exercise for the design of a wooden personal computer. If successful, this exercise will form part of the training centre-based portion of the vocational education for wood technicians (Holzmechaniker) at this school, and will involve the design of different wooden housings to fit a refurbished computer, designed by the pupils.

The electronic parts of the proposed practical exercise to develop wooden computers will be provided by the Reuse-Computer organisation (of which Tricom is part) and come from refurbished used PC's collected by the Project. MicroPro has been advising the School in the development of this Course. The School has agreed to refer to MicroPro and iameco in the prospectus for the course, and have requested an on-going input by MicroPro to this Course.

3.3.2 *Integration of knowledge from external assistance*

4. Project Outcomes

4.1 Environmental Impact Indicators

At the start of the Project, MicroPro set out KEPI for the new prototype, as follows:

Indicator	Result	Source of verification
75% reduction in CO_2 emissions	50% reduction achieved with respect to iameco prototype (which has already 25% less impact than previous prototype)	Fraunofer IZM Report[xxvi] KERP Eco-XPC Report[xxvii]
75% reduction in fresh water use	50-75% reduction would be achievable if display panel is reused 3 times after 1st use.	Iameco II Eco Design Report[xxviii] (Item 5.2.2)
98% of materials recyclable (by weight)	Chassis is made from FSC certified wood and aluminium. No paints or glues used in manufacture that could compromise disassembly and consequently reuse/recycling.	Iameco II Final Summary Results (Item 6 d)
20% materials reusable (by weight)	As above. Chassis and main parts and components are reusable.	Iameco II Final Summary Results (Item 6 d)
Hazardous materials eliminated	All primary system components are RoHS compliant (Component Manufacturer Declarations provided) Components do not contain lead or cadmium	Iameco II Final Summary Results (item 6 f)
Non-recyclable plastics eliminated	No plastics used in the housing.	Iameco II Final Summary Results (item 6 f)
No energy consumption in Off Mode	0.98 W in Off Mode	Iameco II Energy Efficiency Test (item D Sleep Mode)
Life extension to 10 years demonstrated	Iameco v3 is designed for reuse and components selected to achieve this	Not possible to verify, but based on reuse principles, should be achievable.
All working parts accessible, upgradable, reusable	Achieved through design for disassembly and upgrading	Tricom Disassembly Report
Disassembly time reduced to 10 minutes	Achieved through design for disassembly (DFD)	Tricom Disassembly Report Time of disassembly tested by UL ECE

Noise level no more than 25DB in operating mode and 35 DB when accessing disc drive	32.4 DB in operating mode 32.4 DB when accessing disc drive	TUV Noise Test quoted in Iameco II Final Summary Results (item 4 Noise)
Electro-magnetic emissions no more than 259 GHz	Display at both Display Mode A and Display Mode B (at 230 V / 50HZ.) show variations below the level (<10 v/M) permitted by EN50279 for Category A .	TUV (Taiwan) Test Results
Packaging 100% recyclable	Cardboard packaging consists of 100% recycled materials, also recyclable	Iameco II Final Summary Results (item 8 Packaging)
Comprehensive User Information provided	Comprehensive information available in print and through web site.	Iameco v3 Instruction Manual
Guaranteed take Back for Reuse	MicroPro offer a free take back service	Iameco v3 Instruction Manual Pg. 3

4.2 Environmental Impact of Carbon Footprint

The iameco v2 is a vast improvement (> 50% in total and for each life cycle phase, see figure below) compared to the **iameco**, which already was an "eco-PC". This has mainly been achieved by the integration of notebook components, and reduction of size and weight and therefore materials.

According to the assessment by Fraunhofer IZM Life Cycle Primary Energy Consumption of **iameco v2** is roughly 9,000 MJ (6 years lifetime, display manufacturing excluded to make the findings comparable with the **iameco,** which came without a monitor of its own), compared to more than 20,000 MJ of the iameco v2 (recalculated based on KERP's background data).

Applying the EuP methodology (now including the display panel) results in a Primary Energy Consumption of 7,800 MJ (mainly due to the fact, that KERP applied a significant production "overhead", which is not taken into account by the EuP methodology) and a Global Warming Potential of nearly 360 kg CO_2-eq., compared to 761 kg CO_2-eq. as stated by the EuP Preparatory Study for a standard Desktop PC used in an office (Jönbrink, A. K.: EuP Lot 3 "Personal Computers and Computer Monitors" Final Report, 2007).

A life time extension means inevitably a higher primary energy consumption and carbon footprint *per product* as the phase of electricity consumption in use is extended. However, *per year* of use any strategy for lifetime extension results in a reduction of primary energy consumption and carbon footprint.

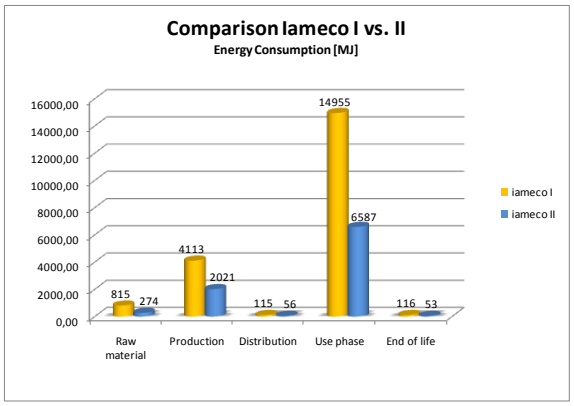

Figure: Energy comparison IAMECO v1 vs.v2

Environmental impact has been minimised by reducing impact of materials in terms of reducing size, number of parts and simplifying design. Design has been simplified, access to all working parts and disassembly made easier. Parts and components have been selected to reduce energy, environmental impact and the product's CO_2 footprint. Eco-design helps protect consumer's health by reducing noise levels and electromagnetic emissions. Plastics in the housing plastics and flame retardants have been eliminated and replaced by wood from renewable forests. Heavy metals and other hazardous materials have been reduced or eliminated.

Life-expectancy of the equipment has been extended from 3 to 10 years, principally by design for disassembly, upgradability, and by maximising the potential for reuse of the product and its components. This avoids the need for wasteful and costly disposal and replacement, that is common to other brands and the principal cause of the international electronic waste problem. To complete this design, packaging is 100% recyclable and effective user information provided.

MicroPro intends to provide the infrastructure for upgrading and take back for reuse through a series of agency arrangements in Ireland and Europe that are currently under preparation. This will operate both nationally and in Europe, to facilitate local upgrading and guaranteed take back for reuse.

4.3 Economic Impact

4.3.1 Economic impact to MicroPro

An analysis of the market potential of the **iameco v3** is outside of the scope of the current project. The establishment of the current economic and marketing potential of the **iameco v3** will be the theme of a future project, possibly involving the EU's Competitiveness and Innovation Programme or similar funding.

4.3.2 Marketing Plan

MicroPro has some marketing information on the likely impact of the **iameco v3** thanks to marketing research carried out on its behalf by KERP as part of Project HEATSUN[xxix], gives a projection of a possible sales and exports growth plan, which could apply to the iameco v3 and related customer service (upgrading, take-back and repair):

Projected market (units)

Year	Iameco v3 (no's of computers)		Peripherals & parts (no's various)		Services (no's various)		TOTAL
Market	IE	Export	IE	Export	IE	Export	All Markets
2011	100	80	300	240	120	80	920
2012	150	220	450	660	180	220	1880
2013	226	480	675	1440	290	480	3590
Total	476	780	1425	2340	590	780	6390

Projected market (income)

Year	Iameco v3 (per unit in € 1,000)		Peripherals & parts (per unit in € 1,000)		Services (no's various)		TOTAL
Market	IE	Export	IE	Export	IE	Export	All Markets
2011	75	80	57	46	24	16	298
2012	150	165	86	126	36	44	607
2013	224	360	128	272	64	96	1144
Total	449	605	271	444	124	156	2049

The expected profits after investment in production are as follows:

Activity	2012 (in €)	2013 (in €)	2014 (in €)
National Sales	156,000	272,000	416,000
Exports	142,000	335,000	728,000
Gross Income	298.000	607,000	1,144,000
Net Profit before Tax	50,000	100,000	200,000

Sales and export income will be derived from the implementation of the sales and exports plan below. In order to make this growth possible, investment will be derived both from grant sources and private investment. Start-up investment in the region of € 150,000 per annum for the first two years of operation would be required. This investment will ideally come from R&D Grants and other private and public sources.

MicroPro's marketing strategy is to first develop its existing client base (for retail products and services) in South Dublin and Ireland generally, for the sale of both **iameco v3's**, peripherals and parts, and associated services (upgrading, repairs, etc.)

At the same time it will begin an export drive, which by the second year of operation should have already become the main source of income. MicroPro will base its activities on its own shop and workshop premises in Dublin, at 98 Nutgrove Avenue, Rathfarnham. It will continue to display and market the iameco range from their premises, as well to give clients direct support, repair and upgrading services from these central premises.

MicroPro is already selling through a number of retail outlets in Ireland, in addition to its own premises. As a prelude to its export drive, MicroPro will identify retail outlets that share a similar ethos in the countries where this expansion is going to take place. This will be done with the help of specialised sector journals and web sites, with the advice of European contacts made in previous projects and events, and with the help of sector networks like StEP (Solving the E-Waste Problem), the FP7 Network and the REUSE Network.

MicroPro to act as the central distribution point for **iameco v3** and peripherals, holding a sufficient stock at any one time to meet the requirements of the proposed export plan. It may be necessary, towards the second or third year of the plan, to identify a second distribution point for Europe, to reduce transport costs and delivery times.

MicroPro will identify agents in the countries where it intends to expand operations, as a first step in entering these markets. These agents will be experienced in the sector, and will identify potential retailers in their catchment area. The Agents will also provide feedback on client responses and feedback, which will inform future marketing approaches and product and service design.

MicroPro already has dedicated sales staff, and these staff members will take a lead in promoting the product range and managing the marketing campaign. These sales staff will be the point of contact with retail and potential clients that contact MicroPro. As the export plan develops, MicroPro will consider appointing sales representatives based in mainland Europe, and able to speak the different languages.

This export strategy is currently being discussed with European partners in the ZeroWIN Project (7th Framework) that have agreed to co-operate in this endeavour. To date GAIA, a Network of electronic companies' network based in the Basque country and the Reuse Computer Network in Berlin have agreed to collaborate as potential agents in this effort.

The MicroPro's web site www.micropro.ie will be translated into the different market languages as they are entered, and the E-Newsletter will be adapted for use in the specific market in consultation with local representatives. MicroPro will develop use of its Web Site as a main tool for marketing. Prospective clients will be able to see the full catalogue of PC's, peripherals and services available, together with detailed user.

4.4 Other Benefits

Iameco v3 brings benefits both to private clients and to corporate clients.

Private clients will benefit from an integrated desktop computer that is:-

- High end design, with quality and high specification materials and components
- cheaper to run, due to lower energy consumption, as evidenced by tests carried out by Fraunhofer Institute, UL ECE and ReUse Computers
- healthier to operate, with less electromagnetic emissions, noise, and embedded hazardous materials
- able to perform multiple functions (e.g. monitors can double up as TV screens, etc.)
- longer lasting, thanks to its easily upgradable design
- easily disposed of , if required, due to take-back and reuse arrangements
- better for the environment – as proven by achieving the EU Eco-Label
- of standard assured by the European Eco-Label
- compliant with European Directives and national legislation (WEEE, RoHS and EuP Directives)

Corporate clients, in addition to the above, will benefit from a computer that meets Green Procurement and Corporate Social Responsibility criteria with respect to reducing the company's carbon footprint and promoting a more sustainable environment.

In addition to the product itself, MicroPro will offer a range of services, with respect to after sales support, repair, upgrading and take-back of end of life products, as well as a 3-year warranty.

4.5 Involvement of other Business

MicroPro will consider appointing suitably qualified enterprises, including social enterprises that have the administrative and technical infrastructure to provide after-sales support, repairs and upgrading to non-Irish MicroPro users, as Agents, to provide this service in their own catchment area. This will be carried out through a franchise arrangement or similar, and will involve a franchise fee being paid to MicroPro, with the bulk of the fees being retained by the franchise holder. At present, this possibility is being investigated with the GAIA network of electronic industry companies in the Basque country, and with the REUSE Network of computer refurbishers in Berlin within the context of the Zero WIN Project.

5. Promotion and Publicity

5.1 Potential Replication in other Enterprises

The **Iameco2 Project,** and the prototype developed, have demonstrated that it is possible for a small enterprise working with limited resources, to implement cutting-edge R&D and eco-design, producing attractive and sustainable consumer electronics that can compete on international markets.

In particular, the need to disseminating the Life-Cycle Assessment approach as a design tool for small and medium sized enterprises that are seeking to make their products more sustainable. In the course of the **iameco2 Project**, MicroPro have become Partners in an FP7 Project led by Fraunhofer IZM, that aims to develop software which is user friendly and will enable SME's to carry out their own LCA's. The Boosting Life Cycle Assessment use in SME's development of sectoral methods and tools, (LCA to Go) Project (THEME 6 ENV.2010.3.3.2-1**)** is the third European Project that MicroPro will partner.

Life Cycle Assessment (LCA) is the most advanced tool for evaluating and improving the environmental performance of products. There are however barriers that reduce its implementation, especially in SME's. The LCA to Go Project aims to boost the use of LCA tools in European SME's. The project wants to overcome the existing obstacles by developing sector specific Eco-design and LCA based tools adapted to the needs of SMEs (rather small "apps", no duplication of commercial software tools) and overcoming the main barriers to the use of LCA by SME's. In this way MicroPro intends to help disseminate the approach undertaken in the development of the **iameco v3** to other businesses in Ireland and elsewhere.

5.2 Dissemination of the Results

The principal dissemination of the results of the Project will be through the marketing of the **iameco v3.** MicroPro's marketing strategy is based on its current marketing experience, and aimed at the market segments identified within the target markets proposed. MicroPro will seek to associate the **iameco** brand with the objective ecological benefits that are contained in their approach as accredited by their compliance with the range of environmental standards and with the European Eco-Label.

The **iameco v3** will have a strong selling point in being compliant with European and national regulatory instruments that determine enforceable standards for the design and manufacture of electric and electronic equipment. This includes compliance with the WEEE Directive and CE compliance.

MicroPro has also adopted the voluntary standards of the European Eco-Label, accredited by the European Commission, which bring together key environmental indicators, including reduction of energy, electromagnetic emissions, noise and hazardous substances, ease of disassembly, upgradability and longer life.

Although the Eco-Label is a voluntary standard at present, it is likely that in future regulatory instruments will adopt similar standards to those currently embodied in today's voluntary standards. For example higher standards of energy efficiency are likely to be required by reviews of the Energy Using Products (EuP) Directive.

A marketing consideration is Green Procurement. The European Commission and many national authorities responsible for procurement are increasingly looking to positively encourage the purchase of energy efficient and environmentally-friendly products by government departments and publicly funded bodies, and are recommending voluntary standards and introducing regulations to facilitate Green Procurement. The move to Green Procurement is therefore one of the most likely policies that could positively influence take up of iameco PCs and similar products.[xxx]

The other principal instruments for dissemination will be the MicroPro and iameco web sites (www.micropro.ie and www.iameco.com) and the proposed iameco electronic newsletter. MicroPro is also participating in two European Projects funded under FP7, both of which involve extensive transnational networks that will help the dissemination of results. It is also likely that the academic and research associates, UL ECE, Fraunhofer and Reuse Computer, will also want to disseminate the experience of the **iameco2 Project** through various networks and conferences.

6. Lessons Learned for the Future

6.1 Lessons

The experience of the **iameco2 project** demonstrates that there are many reasons why computer manufacturers, and other manufactures of consumer electronics, should incorporate remanufacturing/refurbishment processes in their reverse supply chain operations. Few technological barriers remain at a product level that makes this difficult. The Project demonstrates how eco-design has been practically and effectively applied to the development of an integrated desktop computer system.

The disassembly evaluation of the **iameco v2** prototype referred to in the report shows that fundamental principles of eco-design, namely design for life-extension (DfLE) and design for disassembly (DfD) are viable on a practical level for computer systems. DfD and DfLE for computer systems are closely linked to four additional aspects of disassembly namely

i) Accessibility
ii) Replace- and extensionability,

iii) Demount-ability and
iv) Impression of stability of value.

These are design criteria that are clearly under the control of a manufacturing small enterprise. This control does not extend to design input into parts and components at present, but the **iameco2 Project** experience also shows that it is possible to select parts and components on the international market that fulfil the basic requirements of eco-design, particularly in term of universality and durability.

Also it is clear that in order to implement this approach, it is necessary for SME's to move towards a Product/Service System (PSS) approach, where services are provided through the life of the equipment and not just at the point of sale. These services will have to include upgrading, take back, and reuse of whole machines, parts and components.

This requires a change in consumer attitude in favour of reuse and remanufacture, and away from the obsession with newness which is characteristic of electronics consumption. It is vital that the company get their products back as soon as possible post consumer use to ensure time and monetary investment in eco-design is not lost.

6.2 Continuation of the project

MicroPro are partners in the FP7 Environment funded ZeroWIN Project. Within this project, MicroPro are responsible for the Design for Reuse (D4R) Laptop case study, which aims to illustrate how fundamental principles of eco-design, can be implemented in a prototype laptop product. The case study aims to determine exactly what D4R criteria are possible and feasible for a small to medium enterprise. In addition to product specific design criteria, the study will investigate the small enterprise's transition from a traditional direct selling business model, to a lease and take-back based alternative. This transition is required to guarantee the company gets their product back at end-of-life (EOL) and ensure their investment in the D4R is not lost.

The case study will also investigate the feasibility of promoting industrial symbiosis or industrial synergies between the iameco production line and other sectors, like construction. The purpose of this is to demonstrate how additional environmental and economic savings arising from reuse of systems and subassemblies can arise and how further revenues or savings can be achieved from the exchange of material resources/by-products between industrial partners.

MicroPro is currently exploring the possibility of developing a further European initiative, this time to market and disseminate the results of the **iameco2 Project**, in terms of a Bid for Eco-Innovation funding together with the UK Remanufacturing organisation.

6.3 Continuation of Cleaner Greener Production

MicroPro has outlined mainstream manufacturing plans for the **iameco v3** and at the time of writing this report arrangements have been put in place with Geraghty Joinery Ltd in Claregalway and C&F Tooling Ltd, Steel Manufacturers in Athenry, Co. Galway to produce the wooden casings and stainless steel back covers. iameco will be fully manufactured and assembled in Ireland.

MicroPro is committed through iameco to creating jobs in Ireland and developing a large export market leading the way in eco-friendly technology.

iameco – we are ready to go.

7. Main References

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[vii] Recommendation 2003/361/EC a Small Enterprise as one with less than 50 employees, turnover of less than € 10 million and Balance Sheet of less that € 10 million.

[viii] EMA Intentional Ltd. – Feasibility Study for MicroPro Dublin 1999

[ix] See ii above

[x] Werbach. Adam - Strategy for Sustainability A Business Manifesto Harvard University Press 2009

[xi] Stachura, Marek, Schiffleitner, Andreas, - Eco-PC Report, Kerp, Dec. 2008

[xii] See iv above.

[xiii] See v above

[xiv] See ii above

[xv] See iii above

[xvi] Serial Advanced Technology Attachment: a computer bus interface for connecting host bus adapters to mass storage devices such as hard disk drives and optical drives.

[xvii] See vi above

[xviii] As lv. above

[xix] See vi above

[xx] European Commission DG TREN Preparatory studies for Eco-design Requirements of EuPs(Contract TREN/D1/40-2005/LOT3/S07.56313) Lot 3 Personal Computers (desktops and laptops) and Computer Monitors Final Report (Task 1-8)

[xxi] COMMISSION REGULATION (EC) No 1275/2008 of 17 December 2008 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to Eco-design requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment

[xxii] See ii above

[xxiii] See iv above

[xxiv] See v above

[xxv] Hickey, Stewart "Practical Eco-Design Approaches for Personal Computers – A Case Study of the iameco!!" UL ECE 2010.
[xxvi] See iv above
[xxvii] See x above
[xxviii] See vi above
[xxix] Marek Stachura, Andreas Schiffleitner iameco Draft Marketing Section KERP, Vienna, August 2006
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