PROCEEDINGS OF THE

INNOVATION CHALLENGE

GO GREEN

EDITED BY
LEONIE BALDACCHINO


INNOVATION
CHALLENGE
GO GREEN

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FOREWORD

Miriam Teuma
Chief Executive Officer, Aġenzija Żgħażagħ

Launching the United Nations new youth strategy, *Youth 2030 - Working With and For Young People* in September 2018, the Secretary General António Guterres commented that young people were "a vast source of innovation, ideas and solutions", who push for the needed changes in technology, climate action, inclusivity and social justice. "Empowering young people, supporting them, and making sure they can fulfil their potential are important ends in themselves", he stressed. The priorities set out in Youth 2030 include the need to foster a just transition to a low-carbon and green economy.

Green issues and concerns and the role that young people can play in addressing them are also to the fore in Europe, and one of the 11 European Youth Goals set out in the EU's new youth strategy (2019-2027) *Engage, Connect, Empower* is for a sustainable green Europe.

Addressing green issues and coming up with practical and innovative solutions to problems is not merely a global but also a national concern. As a densely populated island nation we need to take positive and practical steps to not only sustain but also enhance our environment. The Innovation Challenge: Go Green is a practical example of one of these steps that others can follow and emulate in their respective fields of endeavour.

Aġenzija Żgħażagħ has undertaken a large number of cooperative cross-sectoral initiatives in recent years to promote the active engagement, empowerment and participation of young people and youth organisations. This includes the ***Innovation Challenge: Go Green***, which was a joint initiative between Aġenzija Żgħażagħ and the Edward de Bono Institute at the University of Malta, that invited young people to identify an environmental problem, come up with a green innovation solution, carry out a feasibility study and submit a proposal for evaluation.

Following an open competition and public presentation of proposals, the winning proposal was Antoine Galea's "Eco-Purifer" project. The runners-up were Calos Canas with "The Butterfly Project" and David Sciberras with "Energy from sewage: An untapped resource". The winner was awarded a trip to the European Conference on Sustainability, Energy and the Environment in Brighton. This publication includes, in full, the three successful submissions and they provide for informative and compelling reading.

I would like to thank all those who participated in this project, particularly our colleagues at the Edward de Bono Institute, Director Dr Leonie Baldacchino and Lecturer Dr Lisa Pace. A special thanks also goes to the young people who submitted proposals, for sharing with us their knowledge, initiative and innovation in addressing issues that are truly global.

CONTRIBUTORS

Leonie Baldacchino

Leonie Baldacchino holds a Ph.D. in Entrepreneurship from Warwick Business School (UK), an M.A. in Creativity and Innovation and a B.Psy.(Hons.) from the University of Malta. She is the Director of The Edward de Bono Institute for the Design and Development of Thinking at the University of Malta, where she has been lecturing on entrepreneurship, creativity and innovation since 2008. Since 2009, Leonie has been involved in the coordination and organisation of various entrepreneurship-related incentives at the University of Malta, including the Global Entrepreneurship Week events hosted locally by The Edward de Bono Institute, and the entrepreneurship stream on the Degree Plus programme. She has also lectured on entrepreneurship, creativity and innovation at Warwick Business School (UK), at Teesside Business School (UK), and at the Malta College of Arts, Science and Technology, and has delivered numerous presentations and workshops in Malta and overseas. Her research focuses on various aspects of entrepreneurship, including the psychology of entrepreneurship; social, sustainable and inclusive entrepreneurship; and entrepreneurship education. She has published locally and internationally, including in the International Journal of Management Reviews, International Journal of Entrepreneurial Behavior and Research, and in edited books by Routledge and Edward Elgar.

Carlos Canas

Carlos Cañas is a Geographer with a background in Geodesy and Cartography and a close interest in the current trends of Geographic Information Systems (GIS). He is currently reading for a PhD at the Institute for Climate Change and Sustainable Development, University of Malta, where he has been working as a Research Support Officer since 2013. His research field of interest is pedestrian mobility and its social, economic and environmental causes and consequences. After having worked as a GIS analyst and consultant, he focused his career path towards Sustainable Development. He is interested in Volunteer Geographic Information (VGI) and Citizen Science, where ordinary members of the public are engaged to cooperate on different GIS-based projects to improve social and environmental conditions. Consequently, he has joined two European research networks supported by COST (European Cooperation in Science and Technology) where he participates actively as a Management Committee Substitute Member.

Antoine Galea

Antoine Galea obtained his diploma in Agriculture from the University of Malta under Prof Everaldo Attard in 2015. He is the founder and manager of the eco-garden landscaping company Garland, where no artificial pesticides and chemicals are used. Water features built by Garland incorporate the eco-purifier concept. He forms part of the Beesavers Malta organisation, which works towards bee conservation and relocating swarms from urban environments into the wild. He is also conducting further research on his eco-purifier with a view to adapt it to purify air as well as water. In his free time he engages in organic farming and has a zeal for afforesting abandoned areas with endemic trees and shrubs.

Lisa Pace

Lisa Pace holds a Ph.D. from the Manchester Institute of Innovation Research (MIoIR) based within the University of Manchester's Alliance Manchester Business School, UK, together with an M.Sc. and a B.Sc. from the University of Malta. She lectures at The Edward de Bono Institute for the Design and Development of Thinking at the University of Malta on innovation management and foresight, with particular interest in environmental innovation and sustainability transitions. She has experience in mapping research and innovation policies and trends in the national landscape in Malta and in the use of foresight and forward-looking tools for policy development. Lisa has participated in European research projects addressing developments in foresight and diffusion patterns of emerging technological innovations. Her publications are in the areas of participatory foresight and environmental innovation. Lisa's current research interests include innovation management, firm capabilities for innovation, foresight and studying low carbon transitions using forward-looking techniques.

David Sciberras

David Sciberras is an entrepreneur, designer and engineer. He is the Director of Invent 3D Ltd., which provides additive manufacturing services to a variety of organisations including the University of Malta, Foster Clark Products Ltd., ElectroGas Malta Ltd., and MCL Components Ltd. He holds a Bachelor of Engineering from the University of Malta, where he is currently nearing completion of his Masters in Integrated Product Development.

1. ABOUT
THE INNOVATION CHALLENGE: GO GREEN

Leonie Baldacchino

The ***Innovation Challenge: Go Green*** was a competition for young people between 17 and 30 years of age. Individuals or groups of up to three members each were invited to identify an environmental problem, come up with a green innovation solution to this problem, carry out a feasibility study for their solution, and submit a proposal for evaluation. Any theme or subject concerning environmental sustainability was welcome, including:

- Water Conservation
- Alternative Energy
- Pollution Reduction
- Waste Management
- Agriculture
- Manufacturing
- Architecture
- Transportation
- Traffic Management
- Urban Planning
- Construction

This competition, which was a joint initiative between Aġenzija Żgħażagħ and The Edward de Bono Institute for the Design and Development of Thinking at the University of Malta, included a workshop where participants received training on green innovation, idea generation, feasibility studies and intellectual property rights. The aim of this workshop was to help participants identify relevant environmental problems, generate innovative solutions, and prepare their submissions for the competition.

Following submission of proposals, a final judging event and award ceremony was held at TAKEOFF Incubator, University of Malta. During this event, three finalists delivered a 10-minute presentation about their proposals, followed by 10 minutes of questioning from the judges and the audience. The proposals were evaluated on their local relevance, potential for internationalisation, innovativeness, feasibility, impact, and clarity by a panel composed of the following five judges.

The panel of judges deliberating the results

1. Dr Leonie Baldacchino
Director of the Edward de Bono Institute, University of Malta (Chair)

2. Mr Jason Zammit
Manager, Aġenzija Żgħażagħ

3. Professor Maria Attard
Director of the Institute for Climate Change and Sustainable Development, University of Malta

4. Dr Ing Anton Bartolo
Director of the Knowledge Transfer Office, University of Malta

5. Ing Tom Cusens
Founding Member of the Malta Chamber of Engineers

ABOUT THE INNOVATION CHALLENGE: GO GREEN

The competition was won by Antoine Galea with his *'Eco-Purifier'* project. Mr Galea noted that since fresh water reserves around the world are rapidly depleting, finding innovative means of purifying contaminated water is an increasingly important challenge. He described a water purification system that mimics natural systems by using micro and macro organisms to purify water, and explained that he had built two prototypes of this eco-purifier and tested them with positive results.

Antoine Galea

In second place was Carlos Cañas with *'The BUTTerfly Project'*. Mr Cañas highlighted the environmental and health hazards posed by the littering of cigarette butts. He suggested setting up a local network which would collect cigarette butts and recycle them into toxic-free plastic souvenirs, which would then be sold to tourists.

Carlos Cañas

In third place was David Sciberras with his *'Energy from Sewage'* proposal. He argued that while the increase in photovoltaic systems was a positive development in terms of green energy use, there are problems associated with solar panels, including the shortage of space available for their installation and their poor recyclability. He proposed an alternative solution which would entail installing turbines in sewage and wastewater outflow pipes to generate electricity.

David Sciberras

The results were announced by Mr Jochen Lenders, who had come up with the idea for this competition while reading for his Master in Creativity and Innovation at the Edward de Bono Institute. The awards were presented by the then Parliamentary Secretary for Research, Innovation Youth and Sport, Hon. Chris Agius. The top prize was a trip to the European Conference on Sustainability, Energy and the Environment which was held in Brighton (UK).

Jochen Lenders

All the three-above mentioned proposals are featured in this publication. The proposals begin with a description of the environmental problem that they address, including an explanation of the issues and challenges that they present, with a focus on the Maltese context. They then include an outline of the green innovation solution that they proposed to tackle this problem, followed by a basic feasibility analysis for the implementation of the solution. A reflection by Dr Lisa Pace, lecturer at The Edward de Bono Institute, on the role of firms in fostering green innovation follows the proposals as a conclusion to this publication.

2. THE ECO-PURIFIER

Antoine Galea
Winner of the Innovation Challenge: Go Green

Introduction: The Environmental Problem

Fresh water is a precious resource required by all industries – it is used as a raw material in every conceivable anthropogenic process. Even though the earth is covered by 98% water, only 2% of it is freshwater – 67% of this freshwater is further 'locked' into glaciers and permafrost (Shiklomanov, 1998). The reverse osmosis system *(RO)* is widely used by all countries to desalinate sea water, thus making use of the larger fraction of our planet's water supply. However, RO treatment requires huge capital expenditure and resources to both operate and maintain, and it also produces a concentrated waste-water stream as a by-product (Joo & Tansel, 2015). Since RO is widely implemented, all industries largely depend on it, leading to an overdependence on state water supply.

When a country places all its eggs in one basket by depending on a singular means to purify water, challenges inevitably follow. In the case of the Maltese Islands, the water reserves last only 48 hours until they are fully depleted (Martin, 2014). To make matters worse, wastewaters are frequently released into the sea or allowed to settle on land and soil. This inevitably seeps through the rock strata, thus contaminating our natural underground aquifers and potentially leading to increased rates of cancer (through the consumption of water rich in nitrates and heavy metals) *(Morales et al., 1995)*. This also threatens the country's food security through the salinisation of agricultural land, as irrigation with saline water leads to a drastic reduction of crop output (Shrivastava & Kumar, 2015).

The need for water conservation in Malta is reaching a critical point - the private sector has been extracting thousands of litres of water per minute for years on end (Malta Water Association, cited in Malta Today, 2011). This rampant extraction will inevitably reach a point of no return considering our very limited rainfall during the winter months. The fast change to Malta's terrain in these past few years is also not helping: Accelerated construction and soil sealing is further disrupting the natural water cycle.

Water in Malta was even perceived as a scarcity back in the 1500s, during the time when our water table was replenished and healthy, in the days where no boreholes and massive water extraction technology existed. During the building of Valletta, regulations were imposed by far seeing Grand Masters that a well should be constructed in every house *(Zammit, 1979)*. This is starkly contrasted to the current situation, where the current building code gives priority not to wells, but to the construction of garages and car spaces with every apartment built. Given the arid to semi-arid nature of the Maltese Islands, there is a great need to conserve and re-use water and make better use of our resources for increased sustainability.

The Proposed Green Innovation Solution

The proposed solution is a natural water purification system which has been named the 'eco-purifier'. This system purifies wastewater in various degrees of contamination, as follows: Water is first aerated, then it is passed through a dense matrix of specially selected micro-organisms and finally through the root systems of select plants which establish mutualism with such microorganisms. After passing through such 'living filters', the water will be rid of its contaminants. The contaminants are rendered harmless and do not get localised or seep elsewhere as in other conventional systems.

The eco-purifier is based on Nature's own construction of wetlands and mangroves. Such balanced and evolved ecosystems, naturally disperse and control low levels of contaminants within their cycle. Through the observation of such patterns, science then steps in to replicate these cycles and maximise their potential by applying technological innovation. Thus, the integration of scientific techniques along with the understanding of nature serves to empower and unite both fields - such is the way forward. In the words of Shauberger (1933), 'mankind has to comprehend and copy nature'.

The eco-purifier has thus been inspired by the emerging practice of shaping modern technology around natural cycles and patterns. It replicates what occurs in natural systems by making use of a varied selection of micro and macro organisms to establish a concentrated ecosystem within a closed cycle. When waste water is directed through this system, it purifies all forms of aqueous contaminants such as nitrates, heavy metals and radioactive nucleotide particles.

The eco-purifier can be set-up in-situ or ex-situ, allowing for wider possibilities of application *(e.g., emergency contamination)*.

while saving costs relating to logistics and materials. There are no filters involved, all contaminants are either rendered into harmless gases (volatilisation) or transferred into living biomass. The basic setup includes a framework which provides the ideal conditions for the water purifying species to thrive, as well as a design which guides the wastewater to the said species within a closed cycle.

The eco-purifier can be used by everyone, from the smallest household to the largest industry. It requires a relatively low financial input for setup and maintenance, while its energy requirements are negligible as it can fully operate through the use of solar panels. Since this method relies on natural means to purify water, it has the added benefits of being aesthetically appealing while also purifying the surrounding air. Being a cost-effective and a harmless technology, it lends itself to being applied at large. If this happens, the above-mentioned environmental problems can be mitigated.

An added advantage of this system is that it can potentially operate without noise and the use of AC electricity – as mentioned above, it can be run using solar energy alone. It can also be automated, set to operate indefinitely with minimum attention required. The main drawback of this system is that it will take around 1-9 weeks for it to operate at full efficiency as it is a living system, therefore takes some time to reach optimum biological maturation.

Pilot Project

At the time of the ***Innovation Challenge: Go Green***, two pilot projects had been enacted, as described and pictured below:

Project One

An eco-purifier was set up in a large pond (65,000 litres) housing various amphibians and swans within an animal park (see Figure 2.1). It was estimated that regular water changes (prior to the setup), totalled to over 1.7 million litres of water being used (or rather wasted) every year. Within two months of the project's initiation, a decrease in the frequency of water changes was already observed. This indicated an improvement in the quality of the water in the pond and justified further research and experimentation.

Figure 2.1: The eco-purifier set up in a 65,000-litre pond measuring approximately 4mX2mX1m

Project Two

The second setup was housed in a laboratory (see Figure 2.2). Its purpose was to analyse the rate and success of water purification from various contaminants. The aim was to deduce the ideal setup of the eco-purifier from the analysis of various experiments, in order to satisfy all the possible applications of water purification. This second project showed a significant result in nitrate purification - managing to completely neutralise a high concentration of nitrates (205ppm) within just over 100 hours of operation. A concentration of 138.3ppm was reduced to 73.2ppm, (total reduction of 65.1ppm during 144 hours of operation). This result shows the great potential of the eco-purifier, considering that studies involving critical toxicity levels (CTL) of copper, amounted to an average of 18ppm for a variety of twelve tropical grasses (Plenderleith & Bell, 1990).

Figure 2.2: The eco-purifier set up in a 40-litre aquarium

Such contaminants are very relevant (and unfortunately prevalent) in the Maltese Islands - the EU has established a directive for maximum nitrate levels but samples of water taken around Malta (from tap water to underground sources) have resulted in abnormally high nitrate levels, up to four times the stipulated maximum amount (British Geological Survey, 2012). Copper is the main element in most animal feeds and industrial chemical inputs, and these waste waters eventually leach into underground water sources to eventually upset ecological cycles and human health.

Studies have linked excess nitrates to increased rates of gastric cancer, while excess copper ingestion can lead to kidney failure and other serious complications (Yazdankhah, Rudi & Bernhoft, 2014). Since copper is an element, it can never leave the cycle once released excessively into the environment. Following the favourable results obtained in project two, steps were taken to explore how the eco-purifier can be applied in a practical context.

Further Development and Practical Applications of the Eco-Purifier

Following the ***Innovation Challenge: Go Green***, further work was carried out on developing the eco-purifier and implementing it in garden landscaping projects, as pictured in Figures 2.3 and 2.4 below. It has been incorporated in the building of ponds and water features to offer clients an ecological alternative for purifying water in their private homes. Further information, an image gallery and a video clip of the eco-purifier in action are available at **www.garlandmalta.com**.

Figure 2.3: Construction of an eco-purifier for a very large pond

Figure 2.4: Eco-purifier applied in a small koi pond in a private garden

Feasibility Study

As previously mentioned, freshwater sources throughout the world are fast becoming a scarce resource. Since water plays a central part in all industries, it is a priority to make water use and water purification as sustainable as possible. All industries are seeking to cut costs related to water purification – large amounts of capital are invested in high-tech water purification systems which consume considerable amounts of energy (maintenance and labour costs excluded).

While firms seek independence from the main water supply to save on costs, the government also seeks to ease large demand in the energy sector. These can be both addressed by effectively re-using waste water generated by the industries by using this cost-effective eco-purifier. Households are not excluded, as the family also seeks to reduce costs related to the use of water, as well as enjoy a positive ambiance and fresh air in their homes. It is now evident that the demand for energy and fresh water is largely there and shows no signs of decreasing through time.

This proposal is based around two important endeavours:

1. To fully develop laboratory analysis and testing to come out with the most effective eco-purifier model standards, which could then be adapted to both industrial uses and small-scale applications.

2. The setting up of a company with administrative, research and development facilities for the creation and marketing of eco-purifier models.

Three essential categories of staff have been identified, and one employee would be required in each category in the first year of operation:

1. A project manager, who would devise systems for the company's workforce to operate in the most efficient way possible. S/he would also be responsible for securing tenders, sourcing EU funds and working in close collaboration with key partners to satisfy all potential markets and marketing needs. An annual salary of approximately €28,000 per annum is estimated.

2. A researcher who would continuously research, experiment and develop new ways to improve the system, finding locally sourced, inexpensive components to be used in builds. An annual salary of approximately €24,000 per annum is estimated.

3. A maintenance technician, who would build long term relationship with clients to provide after sales advice and maintenance for their eco-purifier in case such a need arises. An annual salary of approximately €20,000 is estimated.

The total salaries for this proposed workforce will thus amount to €72,000 for the first year of operation. As the sales of the eco-purifier grow, additional staff would be required to cater for the demand. This will give rise to new vacancies in a most interesting and unique sector, creating 'green jobs'.

Office space and a workspace to research and build eco-purifier models are also required. Estimates based on the Malta Enterprise Business First commercial property rates to rent such facilities locally are of approximately €15,000 per annum (www.businessfirst.com.mt). Additionally, approximately €1,000 per month would be required to cover utilities, communications, materials and running costs. These would include approximately €300 per small scale build for the necessary raw materials, which can be sourced locally.

With regards to marketing and implementation, an intelligent approach is necessary to reach all possible customer segments in the most efficient way possible. This would make sure that the full benefits of water purification are spread all around the islands for maximum effect.

First, liaising with local government and councils might allow for the installation of eco-purifiers in public parks and open areas. Every system would be enacted beautifully and an information placard will be placed adjacent to each and every eco-purifier setup. The placards would serve to inform the general public about the importance of clean water and air, as well as being a free and permanent advert about the eco-purifier company. This would drastically reduce costs related to marketing in the long run. Such public projects can go hand in hand with other water catchment operations (e.g., flood control on the roads). This would avoid the wastage of rain water that is redirected into the sea.

It is hoped that the above-mentioned public projects will generate word of mouth advertising (one of the most effective yet inexpensive ways of advertising in Malta), which will serve as a platform to introduce the eco-purifier to households and industry. The aim would be to completely saturate the local market for maximum ecological benefit, before turning to overseas markets during the second or third year of operation.

Conclusion

With a total capital expenditure of around €99,000, a competent workforce and work space can be secured to develop and produce models within the first year of operation. An amount below €100,000 is not too high, considering that the resources will enable a system which addresses and solves a myriad of serious concerns. The benefits reaped are tangible and assist to mitigate the issues of the current situation with immediate and permanent effect.

There is also a realistic potential for profitable returns: Based on the previous models which were personally built, the cost of materials for the setup did not exceed €300 per model. Maintenance and energy requirements are negligible, especially if the client has a photovoltaic setup in place. It is at this point difficult to estimate the exact cost of an industrial model, as contaminants and volumes of water vary from one industry to another. However, considering the value that the eco-purifier bestows, a minimum potential mark-up of 100-150% could be possible on this technology.

In conclusion, the uses for the eco-purifier are vast and can range from small portable systems for use in yards and sizeable gardens to large scale projects such as public parks, agricultural land, hotels and so on. It will only be a matter of time until the right combination of all factors attributed to the build, along with an intelligent business plan will make the eco-purifier an exemplary success in both financial return and environmental sustainability.

3. THE BUTTERFLY PROJECT

Carlos Cañas
First Runner Up of the Innovation Challenge: Go Green

Introduction: The Environmental Problem

Approximately 6.5 trillion cigarettes are smoked (Novotny et al., 2009) and over 4.5 trillion cigarette filters are littered (Truth Initiative, 2018) around the world every year, making cigarettes the most littered item in the world. Malta is no exception, with over 280 million cigarettes smoked by citizens and tourists every year (WHO, 2013). Due to its small size, high population density and increasing tourist demand, this represents a serious environmental problem for the Maltese Islands.

Over 90% of cigarette filters are made of cellulose acetate, a non-biodegradable plastic that can take from 18 months to 10 years to decompose (Marinelli, 2018). When a cigarette filter is littered in an urban or natural area without adequate waste management service, it might remain there for years, producing negative visual impacts for locals and tourists.

The cellulose acetate is just one part of the problem. Many chemical products are used during the course of growing tobacco and manufacturing cigarettes (pesticides, insecticides, fungicides, rodenticides, etc.), the residues of which may be found in cigarettes prepared for consumption. Cigarette filters are intended to reduce the amount of smoke, tar, and fine particles inhaled during the combustion of a cigarette. For this reason, most of the chemical products in tobacco remain in the filters once the cigarette has been smoked. These include arsenic, nicotine, polycyclic aromatic hydrocarbons and heavy metals, which are released into the environment when cigarette butts are littered (Moriwaki et al., 2009).

In Malta, the wind and rainwater carry almost all the littered cigarette filters to the sea where the damage is even greater. Studies have shown that chemicals in cigarette butt leachate can be acutely toxic to aquatic organisms (Slaughter et al., 2001), with two cigarette filters having the potential to kill all the water fleas in 8 litres (Register, 2000). With the vast majority of the 280 million cigarettes smoked annually being washed into the Maltese sea, the negative impact on the environment and public health of the Maltese Islands is in real jeopardy.

The Green Innovation Solution

There are many ways to tackle the problem of cigarette filter littering, including education, law enforcement, taxations, compensations, or space prohibitions. One partial solution for the cigarette industry could be the creation of biodegradable filters. However, it would not solve the issue of the toxic chemicals added to the filter and they would remain a potential biohazard.

Although there is an increasing willingness to warn smokers about the risk and negative consequences of smoking from government institutions all around the world, cigarettes are legal for adults and they have the right to smoke if they want to. This project does not intend to reduce smoking or the number of smokers in Malta or elsewhere. Instead, the idea is to create a local network infrastructure and methodology to collect cigarette butts in Malta, take them to recycling companies specialised in repurposing difficult-to-recycle materials into toxic-free raw plastic, and then transform them into souvenirs with an eco-added value, such as plastic butterfly-themed ornaments and jewellery (see Figure 3.1). This is the aim of the BUTTerfly project: from butts to butterflies.

Figure 3.1: The BUTTerfly Project: From butts to butterflies

Feasibility Study

To turn this project into reality, Maltese society, public institutions, NGOs and the private sector should take part in a process that would include cigarette filter deposition, collection, management, cleaning, recycling, transformation (cigarette waste into a plastic souvenir) and selling the final product, as outlined in *Figure 3.2*. Its feasibility would therefore depend on a strategy comprising several steps and involving various stakeholders. Further details are presented in the next sections.

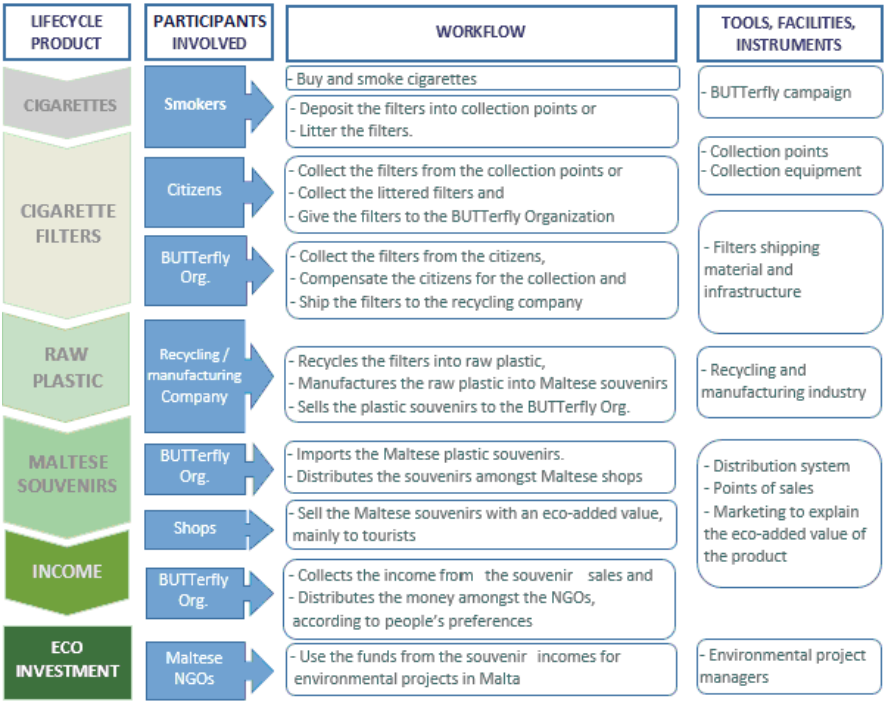

Figure 3.2: Project workflow, participants and resources

The BUTTerfly Campaign

Currently, once a cigarette is smoked the filter can be either deposited in a waste container or littered. Even though there is wide scientific literature about the proven negative impacts of cigarette filter littering, a significant number of smokers tend to overlook the consequences of littering and keep doing it (Action Research Inc., 2009). Different surveys around the world have shown that some smokers do not believe littering their cigarette filters is inappropriate behaviour. In addition, some of them think that because a cigarette filter is small, the environmental impact is imperceptible. The cigarette filter littering problem therefore has a strong cultural component and most of the citizens are not sufficiently well informed.

In view of the above, the first step in the BUTTerfly project would be to carry out an effective information campaign aimed at raising awareness and engaging citizens in the project. The campaign would have three stages. First, the effort would concentrate on informing the public about the non-biodegradable and toxic components of cigarette filters. Second, the campaign would raise awareness about the negative impact that cigarette filter littering has on the environment and public health. And finally, once knowledge about the environmental problems and associated health risks has been conveyed to society, the last stage would be the explanation of the whole project, including the notion of transforming cigarette filters into souvenirs to generate income that could be invested in national environmental projects, and an appeal to citizens to become engaged in the project.

The campaign strategy will depend on external funds until the project generates its first revenues. Due to the positive benefits of the project in the Maltese environment and public health, there could be potential sponsorships from governmental institutions. If the project is supported by modest initial funding the communication campaign would be developed through the innovative and cost-effective use of social media. Nevertheless, in the case of strong initial funding, the campaign would also use traditional media (newspaper, radio and television) to reach the maximum range of the population.

Cigarette Filters Collection Programme

The next step in the project would be to organise the collection of cigarette filters in preparation for shipping them overseas for recycling. According to the Victorian Litter Action Alliance (2011), smokers mainly blame their littering on a lack of well-placed bins for cigarette filters, and many say they would properly dispose of their filters if suitable bins were available. This project shall therefore introduce filter collection point facilities where smokers can deposit their filters.

Although there are some isolated initiatives for cigarette filter collection points in Malta launched by local councils such as beach collection points, it is necessary to implement a national system where the filters do not end up mixed with the rest of the waste material as this would prevent their recycling. The collection points should be spread all around Malta, especially at transition point areas where a smoker must extinguish a cigarette before proceeding, such as outside retail stores, hotels, office buildings, before entering beaches, parks or other recreation areas, and at roadside rest areas, parking lots and bus stops.

Figure 3.3: Small portable ashtrays

The characteristics of these collection point facilities will depend on the funds available. At first, reusable objects such as large plastic containers could be used, before moving on to the creation of specific urban furniture for the deposit and collection of filters. In order to facilitate this procedure, private companies could sponsor the project by providing smokers with portable ashtrays. These portable ashtrays would be small enough to be carried in one's pocket but large enough to store up to 5 filters in a special fireproof box with hermetic closure. The ashtray itself could be a device for advertising for the companies sponsoring the project (see Figure 3.3).

Even though the project campaign aims to encourage smokers to deposit their filters at the collection points, a significant number of filters will continue to be littered in public areas until the idea takes hold. Collection volunteer groups would therefore need to be organised to collect filters from the streets and open areas. In order to facilitate this procedure, the project will provide the volunteers with collection equipment such as gloves and bags. In order to motivate them further, a new organisation (BUTTerfly.org) will compensate their efforts by giving donations to a Maltese NGO of their choice, depending on the amount of filters collected.

In this sense, Maltese NGOs and social organisations could play a very important role within the project. They could organise the groups to collect the filters and obtain the economic benefits that will help fund their non-profit institutions. Although any citizen could collect filters on their own, a hierarchical structure with different collection working groups would be the more efficient way to proceed with the process.

Shipping and Recycling Filters

When a sufficient number of filters have been accumulated at the collection points or gathered by the volunteer groups from public areas, they would be delivered to the BUTTerfly organisation, which will be in charge of shipping them to the US for recycling. TerraCycle (www.terracycle.com) is a highly-awarded, international recycling company that collects difficult-to-recycle material and repurposes it into affordable, innovative products. TerraCycle's in-house R&D team creates plastic formulations and processes waste into valuable raw materials such as customized plastic pellets of various material compositions. These resins can be processed through a variety of manufacturing techniques to create unique products made from recycled waste (see Figure 3.4).

Figure 3.4: : Creating unique products from recycled waste

The BUTTerfly organisation will collaborate with TerraCycle to ship the filters, recycle them into new products and import them back to Malta to sell them as new eco-added-value souvenirs, such as Maltese crosses and butterfly ornaments.

The BUTTerfly organisation will be in charge of the distribution of the souvenirs amongst the Maltese shops willing to cooperate with the project and they would get a commission according to the BUTTerfly souvenirs they sell. The organisation will then collect revenues generated from the sale of the souvenirs and redistribute the funds to finance the cost of the project. Any surplus funds will be used to finance environmental research and projects conducted by Maltese NGOs.

As Malta has a significant tourist market, the souvenirs would be aimed at tourists who would finance the system through their purchases. Each souvenir will include a tag to explain to tourists that the money used to buy the souvenirs will be used to finance not only the collection and recycling of cigarette waste but also environmental research and projects.

The cost of the shipping would be covered by the recycling company, however, the cost of the BUTTerfly management and administration work will be part of the cost structure for the project, as estimated in Table 3.1.

Table 3.1: Cost estimates for the first year of the project

YEAR 1	COSTS
Campaign	€6,000
Butts recollection	€12,000
Storage and transportation	€10,000
Recycled souvenirs purchase	t.b.e
Shops commission	t.b.e
Management and administration	€12,000

Conclusion

The BUTTerfly project is an innovative solution to the problems caused by littered cigarette filters. If implemented, the final result would be an improvement of the Maltese urban and natural environment that eventually has a positive impact on the Maltese lifestyle and the quality of public health, and eventually all stakeholders would benefit from a cleaner Malta.

This project intends to be both non-profit and self-financing. In principle, the income from the recycled plastic Maltese souvenirs sales would completely finance the costs of the project, including economic compensation for the filter collectors that eventually will be used as funds for the Maltese NGOs they choose. However, the income from the recycled plastic souvenirs sales is one of the last stages within the project workflow. Moreover, funds will initially be needed to finance the tools, facilities and instruments to generate the final product before the project creates revenue from itself. Due to this fact, the project will need initial investment and it is open to other revenue streams, public funds from both national and European institutions or private funds from companies.

In addition to funds, the success of the project relies very heavily on the willingness of smokers to collect their cigarette butts and return them for recycling, and on the involvement of a large network of volunteers to assist in the collection process. Market research needs to be carried out to assess citizens' views and willingness to be involved in this project but, given its potential benefits, it is hoped that any early resistance can eventually be overcome.

4. ENERGY FROM SEWAGE: AN UNTAPPED RESOURCE

David Sciberras
Second Runner Up of the Innovation Challenge: Go Green

Introduction: The Environmental Problem

Renewable energy has boomed in recent years. While various options are available, photovoltaic systems (or solar panels as they are commonly known) have become the main solution to reducing electricity costs in Malta. Attractive pricing schemes and grants have led to a huge amount of solar panels being installed on both a domestic and an industrial level. While this is good news in terms of green energy use, there are problems associated with relying on solar energy to generate electricity.

First, they are only 20% efficient at best. When dirty, efficiency rating can drop to 15% and in our dusty climate this frequently happens. During winter, these panels also struggle due to the lack of direct sunlight (Bergin et al., 2017; Maghami et al., 2016; Nunez, 2014). Furthermore, there is a very limited amount of space available in Malta. Rooftops are already getting close to saturation point in this aspect. There will come a time where expansion will not be an option; where one cannot simply add another panel to aid in saving electricity. There already is the problem of height, where solar panels installed on the roof of a house end up in the shadow of a newly developed, much higher stack of apartments, rendering said panels almost completely useless. People will need to turn to a more efficient system, to harness what they can of the solar energy available to them (Jordan & Kurtz, 2012; Maghami et al., 2016).

Another problem, perhaps the one with the greatest environmental impact, is the disposal and recyclability of the panels (Nunez, 2014). Eventually, all the solar systems installed will reach the end of their life. This may be due to upgrading to a more effective system, or simply because the product itself will fail. Currently, a large number of manufacturers provide a 25-year warranty on the power output of the solar panel, but the average lifespan has been researched and proven to be less than that. The National Renewal Energy Laboratory has presented research indicating that the lifespan is more like 17 years. In addition to the panels themselves, the batteries and invertors have to be replaced every 5-10 years (Jordan & Kurtz, 2012) and a great deal of polluted sludge and contaminated water is generated as a by-product of solar panel making (Kelly, 2017).

Solar panels are therefore a ticking time bomb in the world of recyclability. This problem is serious enough to warrant EU concern, with the net volume of broken, used and discarded panels estimated to reach 5.8 million metric tons by 2026 (Walker, 2013). There are currently very few collection agencies in Europe for this industry, and the rate of industrial growth in this sector is not allowing the recyclability aspect to catch up.

The rising energy needs in today's technology-hungry society means that another source of electricity is required. The environment is precious to all of us, and needs to be preserved. A new solution needs to be found, one that reaches into untapped resources with as minimal an impact on the environment as possible.

The Green Innovation Solution

The proposed green innovation solution is to install a form of turbine inside Malta's wastewater system to generate electricity, in a project that has been named 'Energy from Sewage' (EFS). In essence, this is similar to the regenerative braking systems that modern electric cars utilise to charge the batteries while still moving. While this will not replace solar panels, it is aimed to reduce the general prices of electricity which in turn reduces the need for domestic photovoltaics.

Malta's sewage system collects domestic and industrial waste, as well as unquantified amounts of storm water runoff. It is made up of roughly 1,545 km of sewage collection networks, 4 sewage treatment plants and 104 sewage pumping stations, and it treats 67 million litres of sewage per day (www.wsc.com.mt/maltas-sewage-system-in-numbers). A small percentage of this treated water is used as second class water for irrigation purposes, but most of it is returned to the sea through discharge points (WSC, 2017). This is all untapped potential energy which could be repurposed for more energy. One of the treatment plants, known as Ta' Barkat, already harvests biogas from the fermentation (WSC, 2017); this system proposes to take it a step further.

This proposal is to make use of this flow of sewage and wastewater, by installing in-line or parallel turbines. These would spin as waste material flows through them, generating electricity. The electricity generated will then be connected to the grid, therefore lowering the need for more conventional fuels.

The system could be developed as a modular part which would slot into the main with minimal interference to the system as a whole, as pressure drop would be minimal. A parallel system as shown in Figure 4.1 may be easier to implement at first, as it can be phased in by gradually increasing the flow of sewage through it. Furthermore, the parallel nature of the turbines would allow the amount of sewage passing through them to be regulated, and maintenance would also be easier to perform.

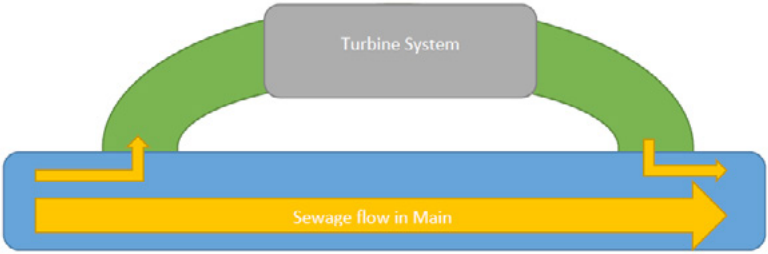

Figure 4.1: Proposed parallel turbine system along the sewage main

The turbine design is important - if it is too intrusive it can cause massive blockages and sewage overflows nationwide. The turbine used by LucidEnergy™ (www.lucidenergy.com), who are pioneers in harvesting renewable energy after having already implemented a similar system in the US, is deemed to be the best design in this case (see Figure 4.2). The patented turbine design can be scaled down for practical use in Malta, as suggested in this proposal.

Figure 4.2: Turbine Technology by LucidEnergy

The system itself comes in a variety of sizes:

Table 4.1: System dimensions, flow rates and power capacity

Pipe Diameter Required /mm	Flow Rate Required / m^3/s	Power Capacity / kW
600	1	18
1050	2.7	50
1500	5.6	100

The project may be scaled to have a maximum payback period of 10 years. Among its advantages are that it causes no damage to the surrounding environment and that it provides predictable energy, regardless of weather.

A quick calculation indicates that the daily wastewater capacity average is of 72,700m^3, or 0.85m^3/s. Applying this to a pipe diameter of 500mm, a single turbine can produce 18kW of energy. A pipeline of this size in series can provide much more. The system proposed can be implemented on other scales if needed, such as individual industrial waste streams, as well as gravity mains transporting water. The final aim is to lower domestic and industrial energy bills while saving the environment.

Feasibility Study

The feasibility of the Energy from Sewage (EFS) project depends on a number of factors. As outlined above, its aim is to harvest untapped potential energy by implementing the system at the wastewater processing plants. Three sites will be considered: Ta' Barkat in the south-east of Malta, iċ-Ċumnija in the north-west of Malta, and Ras il-Ħobż in Gozo. The areas identified would need to be inspected for the best possible location for the EFS system. The site would need to be prepared in terms of area for the piping and any electrical connections, while being as non-intrusive as possible on present buildings and ecosystems. As this project is dealing with government-owned properties, permits would need to be acquired and health and safety rules established.

The most important aspect of this solution is the turbine system itself. It would need to be manufactured in Malta under license or imported. The system can be assembled and connected while maintenance is being carried out for minimal disruption of routine. Heavy machinery would be required to move heavy sections of pipe, and a workforce would be needed to operate the machinery, to address electrical and mechanical issues, and ensure health and safety standards.

Collaboration with several subcontractors and suppliers would be necessary in building and operating the turbine system. A design team would be commissioned to create a 3D model of the system. Piping suppliers, turbine manufacturers and assembly teams would need to collaborate to ensure that the system is correctly created and assembled. This is necessary in order to prevent issues such as premature bearing failure, leakages, incompatible part tolerances, etc. Electrical suppliers would need to source suitable convertors to efficiently convert the rotational energy into electricity.

Furthermore, collaboration is required with the Government-owned Water Services Corporation (WSC) as it governs Malta's water and sewage. It is hoped that the WSC would be interested in this project as there are currently no systems in place that harvest this type of energy, or indeed any form of flowing energy in Malta. The energy recovered can then be plugged into the national grid as it is a Government-controlled entity, leading to lower energy tariffs.

As far as direct competitors in this field of energy are concerned, there are none in Malta. However, one must consider that photovoltaic systems are well-established and might be preferred by potential customers due to their familiarity. It is hoped that industrial customers would be attracted to the EFS system if it aligns with their energy goals.

A large-scale project such as this would entail a considerable investment, but if the correct size of pipe diameter is selected and pitted properly, the payback period of the initial investment is projected to be no more than 10 years. EU funding would also be sought to support the investment. It is likely to be eligible for such funding since it is a sustainable project that would aid in lowering the country's emissions as well as future waste.

In terms of revenue, the system could be profitable in two ways. The WSC may choose to implement the EFS system and take control of the project. In this case, electricity could be sold per unit, and all employees, operation and maintenance of the system would be in EFS employment against a moderate initial investment from WSC. On the other hand, the WSC may opt to buy and implement the EFS system as a unit itself, much like buying a car. In this case, it would be in charge of operation and maintenance but electricity production would be essentially free to them. This would require WSC to make a much higher initial investment.

Conclusion

As a solution to the rising energy needs, the EFS system is a clean, refined, efficient and innovative solution that overcomes some of the problems associated with other methods of electricity generation. Although further research is required to confirm its technical and financial feasibility, the efficient use of an untapped resource is an attractive proposition, and this system ticks all the boxes.

5. CONCLUDING REMARKS
THE ROLE OF FIRMS IN GREEN INNOVATION

Dr Lisa Pace

Being innovative is a prerogative of successful businesses and ensures their survival in a competitive market. Innovation for environmental purposes has also gained sufficient momentum, primarily in response to stricter environmental regulation, and also as issues around corporate social responsibility are becoming a point of discussion on the business agenda. Green innovations are often not entirely 'new' to the adopting firms that are required to make small or step-wise improvements or modifications in existing production lines and products.

A green innovation is not only understood to be a novel technology that avoids or reduces harmful environmental impacts. It more broadly encompasses new and modified production processes and management systems that help achieve these environmental benefits. The family of ISO 14000 standards was developed to support companies and other organisations implement environmental management systems and align environmental goals with the companies' strategic orientation.

Pollution control can be achieved through developing technologies that remove contaminants from the air or waste water arising from the production process. There are several examples of such 'end-of-pipe' measures; perhaps amongst the most notorious are the catalytic converters inserted in automobile tailpipes and the treatment of sewage that has had a significant impact on preserving water quality (Eder & Sotoudeh, 2000).

Many companies adopt green innovations without the specific aim of reducing environmental harm; environmental benefits thus arise as a side-effect of business strategy. Nonetheless there is a growing number of firms in which environmental goals are high on the agenda and feature in their corporate social responsibility programmes. The unforeseen benefits of being "green certified" or carrying a "sustainability label" often come as greater marketing advantages and are increasingly sought after by customers.

The more proactive firms are adopting new business models that deliver competitively priced goods and services whilst reducing environmental impacts and resource intensity. Implementing a 'green' business model may involve firms rethinking existing supply chains and building green channels through which to deliver their products and services; diversifying revenue streams through developing leasing models; and developing new business relations, for example with entrepreneurs engaged in the green movement (AMEC, 2013). Value is understood not simply in economic terms but also in environmental terms.

terms. Although difficult to quantify, environmental value may be created through minimising resource use or through procuring energy efficient equipment and locally-sourced goods with a reduced carbon footprint. These examples demonstrate how it is possible to decouple economic growth from environmental impact and degradation. The challenge is that of identifying cleaner technologies and environmentally-friendly innovations with the potential to achieve economic gains whilst ensuring ecological improvements.

Shifting Towards Sustainable Production and Consumption

Arguably innovations that result in slight modifications of existing systems of production are unlikely to result in a dramatic shift in the way products are produced and consumed. For example, in the field of energy and climate, several countries are likely to achieve carbon dioxide emission reduction targets by increasing the efficiency of current systems. This does not necessarily imply that they are striving towards improving sustainability in the way of environmental preservation and conservation of resource use.

Radical innovation promises to have a higher impact on changing current modes of production and consumption and breaking path dependencies (Geels, 2002). Implementing radically new technologies and processes would require making significant changes not only in the way goods are produced and transported to their destination, but also in the way of modifying practices of consumption amongst users including businesses, consumers and individuals.

Greening Through System Change

Achieving sustainability in entire systems (of energy, food production, transportation and mobility) requires new principles that guide companies and consumers on how to identify opportunities for change that make a difference. One such change is steering the market from being product-oriented to becoming service-oriented: firms shift away from merely providing a physical product or service to a customer towards providing a dematerialised service, or a job done with less material usage. In a near future, consumers will no longer request specific products; rather they will seek to purchase the functionality that products and services traditionally fulfilled. One example in transportation is a shift away from car ownership towards on-demand mobility that includes options such as ride-sharing services. These innovative services, combined with technological solutions aimed at reducing vehicle emissions, represent additive measures that together could have a significant impact on transitioning towards smart mobility and transportation.

The energy sector provides another interesting example of prioritising functionality in energy consumption. Electricity production that was largely centralized in most countries, is now becoming more distributed: individual households, apart from companies and public sector organisations are producing their own energy requirements and selling any excess to the grid. There is a sense of empowerment and greater responsibility over energy management that may also encourage behavioural changes in energy consumption.

Distributed energy systems promote the emergence of new business models, for example in the way of ESCOs (energy services companies) which fund energy saving solutions for their clients and derive revenue from the savings made, thus promoting the concept of 'negative kilowatts'. Another transformation is in the operations management that requires companies to include sustainability concepts along the supply chain e.g., by shifting to closed loop supply chains that conserve and/or use fewer resources. Achieving dematerialisation of services requires creating demand for green innovations such as through green public procurement. This could evolve through companies establishing long-term and stronger relations with their clients and suppliers in order to stimulate a shift in behaviours and lifestyles.

Conclusion

There could be several pathways to achieve a sustainable future with different possible alternatives: one of the key challenges is to identify those opportunities for change that can make a difference. In order to do so, there is a need to engage a broad range of stakeholders to build a common set of visions about a sustainable future and to identify concrete opportunities to achieve sustainability goals. The ***'Innovation Challenge: Go Green'*** was a step in this direction.

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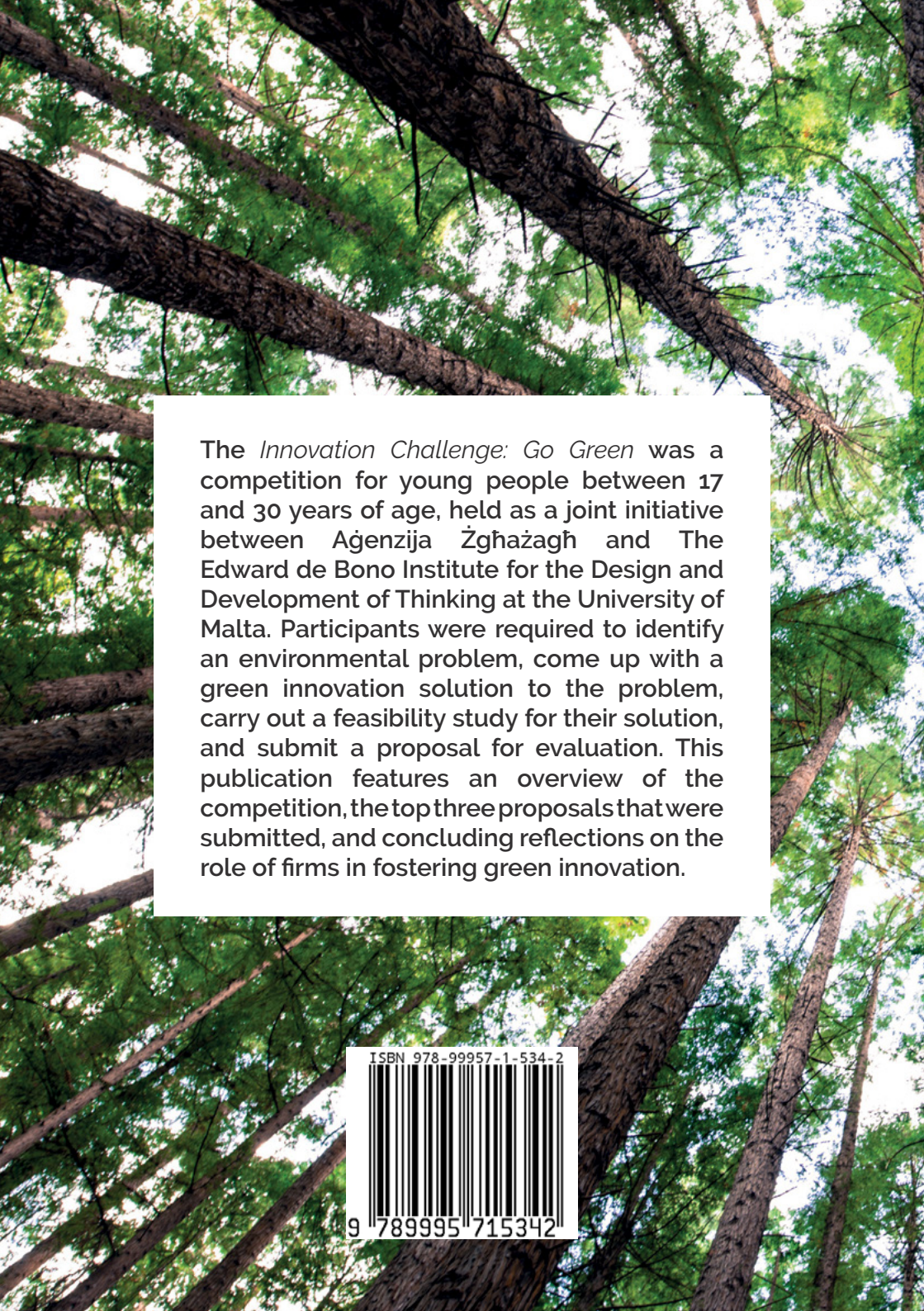

The *Innovation Challenge: Go Green* was a competition for young people between 17 and 30 years of age, held as a joint initiative between Aġenzija Żgħażagħ and The Edward de Bono Institute for the Design and Development of Thinking at the University of Malta. Participants were required to identify an environmental problem, come up with a green innovation solution to the problem, carry out a feasibility study for their solution, and submit a proposal for evaluation. This publication features an overview of the competition, the top three proposals that were submitted, and concluding reflections on the role of firms in fostering green innovation.

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