Material Efficiency | Energy Efficiency | Sustainable Urban Environment

Kirsti Cura and Maarit Virtanen (eds.)

Lahti Cleantech Annual Review **2015**

Lahti University of Applied Sciences
Lahti 2015

Lahti Cleantech Annual Review **2015**

LAMK **Lahden ammattikorkeakoulu**
Lahti University of Applied Sciences

The publication series of Lahti University of Applied Sciences, part 14
Editor-in-chief: Ilkka Väänänen
Layout: Ankara Design / Anna Räikkönen
ISSN 2342-7493 (print) ISSN 2342-7507 (net publication)
ISBN 978-951-827-243-7
Printed by: N-Paino Oy

Contents

About the Authors

Aarrevaara Eeva, DSc (Arch.), is a principal lecturer at Lahti University of Applied Sciences, Faculty of Technology, in the Bachelor's Degree Programme in Environmental Technology and Master's Degree Programme in Urban Sustainability. Her main interests are urban development and communication in planning processes, the impact of climate change on the built environment, rural planning and cultural heritage. She works in several RDI projects.

Autio Sakari, MSc (Env. Econ.), BSc (For.), is a lecturer at Lahti University of Applied Sciences, Faculty of Technology, in the Degree Programme in Environmental Technology. His main interests are resource efficiency, waste management, recycling, industrial symbiosis and new cleantech technologies. Autio is active in several RDI projects.

Carroll Paul, MSc (Env. Tech.), is a lecturer at Lahti University of Applied Sciences, Faculty of Technology, in the Degree Programme in Environmental Technology. He specialises in integrating practical cases from the public and private sectors into learning units, which is facilitated by relevant RDI project participation.

Heikkinen Reijo, Lic. Sc. (Tech.), is a senior lecturer at Lahti University of Applied Sciences, Faculty of Technology, in the Degree Programme in Process and Materials Engineering. His main expertise is in processing and tooling for plastics. His other interests include energy production, energy efficiency and environmental issues of plastic materials.

Kilpi-Koski Johanna, MSc (chemistry and biology), is a Business Development Manager in Lahti Regional Development LADEC Ltd. She is working in the Business Region Development team. Her interests are EU funding, regional business development and cleantech-related issues.

Malinen Essi, BEng, is a student at Lahti University of Applied Sciences, Faculty of Technology, in the Master's Degree Programme in Environmental Technology. She is doing her Master's Thesis about water protection in Lahti.

Manskinen Kati, DSc (Tech.), is a research, development and innovation director in the field of clean and dynamic environment at Lahti University of Applied Sciences. Her main interests are in circular economy and clean technologies. She has an extensive expertise in utilisation of industrial by-products and monitoring of sustainable operations. She has a strong background based on several years' working experience in the board industry.

Matilainen Marianne, MSc (Inf. Tech.), is a senior lecturer at Lahti University of Applied Sciences in the Degree Programme in Information Technology. She specialises in data networks.

Medkova Katerina, MSc (Metallurgy), M.I.B. (International Business Management), is a Lahti University of Applied Sciences alumni and currently also a student at the Faculty of Technology, Bachelor's Degree Programme in Environmental Technology. She is doing her final thesis on circular economy.

Nylander Noora, MSc (Pack. Tech.), BA (Pack. Design), is a senior lecturer and programme coordinator of Packaging Design and Branding at Lahti University of Applied Sciences, Institute of Design and Fine Arts. Her main interests are sustainable packaging and industrial design, inclusive packaging design and development of new packaging solutions.

Rosberg-Airaksinen Eira, Lic.Phil. (Regional Science) is a sustainable development coordinator at City of Lahti, Lahti Region Environmental Services. Her work is among climate change issues, ecological sustainability and environmental reporting.

Tarvainen Ilkka, MSc (Wood Tech.), is a senior lecturer at Lahti University of Applied Sciences, Faculty of Technology, in the Degree Programme in Process and Materials Engineering, Wood Technology. He is involved in RDI projects, and has a strong background based on several years' working experience in the mechanical wood industry.

Vanhanen Mika, MSc (Tech.), BBA (For.) is a teacher at Lahti University of Applied Sciences, Faculty of Technology, in the Degree Programme in Process and Materials Engineering, Wood Technology. His main expertise is in RDI projects, and he has a strong background based on several years' working experience in the mechanical wood industry and forestry.

Vauramo Saara, PhD (Ecology), is a development manager at City of Lahti, Lahti Region Environmental Services. She runs a team of environmental experts working with climate change mitigation and adaptation and environmental reporting of Lahti city consortium.

Virtanen Maarit, MSc (Admin.), is an RDI Specialist at Lahti University of Applied Sciences, Faculty of Technology. She is also Environmental Manager for Lahti Ski Games 2016 and the Nordic World Ski Championships 2017. Her main fields of expertise include circular economy and resource efficiency. She has also international working experience as Environmental and Climate Change Specialist.

Kati Manskinen

Preface

This Lahti Cleantech Annual Review continues a series of publications launched in 2014 for the first time. In this review, experts from the Faculty of Technology and Institute of Design, Lahti University of Applied Sciences, as well as some partners, present their latest interesting research and development projects in the field of Cleantech.

Cleantech refers to clean technologies, i.e. all products, services, processes and technologies which promote the sustainable use of natural resources and reduce the environmental impacts. New clean technologies and innovations are needed due to the fact that the world's population currently consumes the equivalent of 1.6 planets. Resource efficiency by itself will not guarantee steady or declining resource use. Systems may become more efficient but still put excessive demands on the environment. Thus, to achieve sustainability, ecosystem resilience also has to be in a focus.

One essential step to promote ecosystem resilience is to move towards a more circular economy system. In such a system natural capital is enhanced by controlling the finite stocks and balancing natural renewable resource flows. Further, waste is eliminated and resources are kept in the system as long as possible so that they can be productively reused and thus create added value. New clean technologies related to the circular economy may include innovations for example in the context of energy efficiency, recycling and nutrient loading. Moreover, digitalization and new smart solutions are in key roles. Even though this review focuses on clean technologies, it is worthwhile to point out that the transition to the circular economy system implies innovations not only in technologies, but also in organisations, society, finance methods and policies.

The research, development and innovation activities at Lahti UAS in the theme of Cleantech focus on resource efficiency and sustainable urban planning. Cleantech enhances the competitiveness of the business in the region by management of by-products and improving the material and energy efficiency. Furthermore, it contributes to a clean and healthy environment by promoting responsibility, participation and social sustainability.

In this review, the latest Cleantech activities of Lahti UAS are presented from various points of view. In the first article written by Katerina Medkova and Sakari Autio, the circular economy concept is explored and interesting experimental findings of challenges in the transition towards it are presented. Two articles in this review describe the new methods for renewable bio-based resources; the first article by Noora Nylander focuses on quick prototyping in fibre-based packaging design, while the second article by Ilkka Tarvainen and Mika Vanhanen presents 3D hot forming technology for processing of wood. The significance of utilisation of renewable raw-materials is also implied in the article by Reijo Heikkinen that tells about challenges of collecting the plastic waste from the ocean.

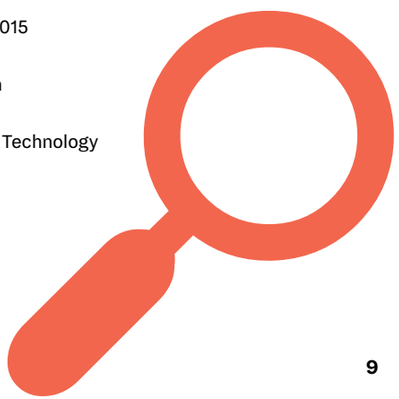
The theme of energy efficiency is extensively described in four articles of this review. Our partner, the City of Lahti, proceeds with great ambition in climate mitigation, and this review presents the concrete actions to achieve the future energy efficiency targets in the City of Lahti described by Saara Vauramo and Eira Rosberg-Airaksinen. The importance of urban planning in promoting the energy efficiency is shown in one article by Eeva Aarrevaara and, moreover, one article by Paul Carroll deals with the aspect of consumer behaviour through student projects. In addition, the improving of energy efficiency by means of Green ICT in small and medium size companies is described in an article by Marianne Matilainen and others.

In her article, our partner Johanna Kilpi-Koski from Lahti Region Development LADEC Ltd presents an excellent concept which develops smart test beds for companies to pilot and demonstrate their sustainable and innovative technologies, products and services. Furthermore, an article by Essi Malinen and Eeva Aarrevaara describes the water protection in the Lahti Region from an interesting historical point of view, and another article by Maarit Virtanen gives a future overview of the environmental management system of the Lahti Nordic World Ski Championships 2017.

I warmly thank all authors, who made it possible to publish this review. I am glad that our partners from the City of Lahti and LADEC had a chance to present their research and development actions. I also wish to express my warm gratitude to editors Kirsti Cura and Maarit Virtanen, and to Maija Varala for revising the language. Sustainable development is a long journey. This review is one step in that journey. It shares the knowledge of the latest activities and innovations in the context of Cleantech, promotes the implementation of these themes and, in this respect, also enhances sustainability.

Lahti, 13 November 2015

Dr. Kati Manskinen
RDI Director
Lahti UAS, Faculty of Technology



References

Ellen MacArthur Foundation [referenced 29.10.2015].
Available at: http://www.ellenmacarthurfoundation.org/circular-economy/interactive-diagram

European Commission. 2014.
Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions: Towards a circular economy: A zero waste programme for Europe /* COM/2014/0398 final/2 */ [referenced 29.10.2015]. Available at: http://eur-lex.europa.eu/legal-content/FI-EN/TXT/?uri=CELEX:52014DC0398R(01)&from=FI

European Commission, 2015.
Towards a green economy in Europe [referenced 29.10.2015]. Available at: http://ec.europa.eu/environment/basics/green-economy/index_en.htm

The Guardian. 2015.
Humans have already used up 2015's supply of Earth's resources [referenced 29.10.2015]. Available at: http://www.theguardian.com/environment/2015/aug/12/humans-have-already-used-up-2015s-supply-of-earths-resources-analysis

Katerina Medkova and Sakari Autio

Towards Circular Economy: EU, Finland and Lahti Region Perspectives

This article is based on research conducted as a part of a Bachelor's Thesis in Lahti University of Applied Sciences during autumn 2015. The objective was to explore the circular economy concept and to define its potential stimulants and existing challenges. The goal was to present examples and cases and thus raise the awareness and understanding of circular economy.

First, the vast sources of literature were reviewed and served as a foundation for the empirical part of the research. In the empirical part, altogether six in-depth interviews were done. Their aim was to obtain enriching opinions from various sectors, from governmental and public sector to a local service provider and a researcher. Thereafter, these findings were analysed and compared with the theoretical facts.

Circular Economy Concept

The unsustainable exploitation of natural resources, the globally fast-growing population (now over seven billion inhabitants) and the sought economic growth cause a continuously increasing demand for food, water, materials and products, energy and even space. As a consequence of these megatrends, the Earth will eventually go bankrupt. Based on the European standard of living, the world population would require four planets to meet the needs. Yet, we still have only one planet. Some of the natural resources are already becoming scarce and this has a direct impact on our economy. Also, the environmental pressures caused by human activity, as well as declining biodiversity and high unemployment need to be addressed.

Our current economic model, the linear model, is based on the assumption of an abundance of cheap and easily available natural resources, as if there had been and always will be a never-ending supply of virgin materials. The 'take-make-use-dispose' approach leads into enormous wasting of natural resources and waste is considered something with no value. Materials are lost and often contaminated.

Today's producer-consumer system is based on producing quantity rather than quality, with products that have a relatively short life cycle and build-in obsolescence in order to sell new products and new models, without paying attention to what happens with the disposed products. Disposal is not often part of the producers' responsibility or even interest. This alarming unbalance calls for a change, urgently. A solution can be seen in a new model of circulating resources, a circular economy.

Figure 1. Traditional industry (photo Maarit Virtanen)

A circular economy is a wide concept based on several schools of thought and, therefore, no single date or author exists. The framing philosophies are: regenerative design, performance economy, cradle to cradle design philosophy, industrial ecology, and biomimicry.

The restorative model of a circular economy regards waste as 'food' or resource for new processes. Waste is seen as a valuable bank of nutrients, materials and energy. In fact, this approach creates resource abundance. Its principles are based on minimizing the impact on the environment and the waste creation as close to zero as feasible, and eliminating the use of toxic chemicals. Ultimately, the system is powered by renewable energy. The added value in products is kept as long as it is viable, and the closed loop systems bring benefits for the economy, environment and society. The concept accelerates job growth and builds long-term prosperity, well-being and safety of society and the ecosystems.

One of the major goals of a circular economy is to decouple the economic growth from the resource consumption by promoting innovation, smart design and co-design, knowledge sharing, and cooperation and collaboration. In the circular economy, nutrients and materials are intentionally designed to cycle in closed loops, in the same way as in nature's biological cycles.

The material flow is depicted in Figure 1. The butterfly diagram illustrates the flow of (1) the biological nutrients, on the left, which are designed to safely re-enter the biosphere and (2) the technical materials, on the right, which circulate within the techno-sphere with a minimal loss of quality and value. This metabolism is driven by the use of renewable energy. Biological and technical materials circulate in loops. A circular economy aims at closing these loops to avoid any leakage. The closer to the centre the loops are and the longer the products/materials stay there, the higher value is preserved and the more resource efficiency is achieved. As Stahel stated: "Don't repair what is not broken; don't remanufacture what can be repaired; don't recycle what can be remanufactured." If the circulation of the inner loops, in particular, is organized on a regional level, it supports job creation and there are considerable economical and environmental savings due to avoiding double transportation.

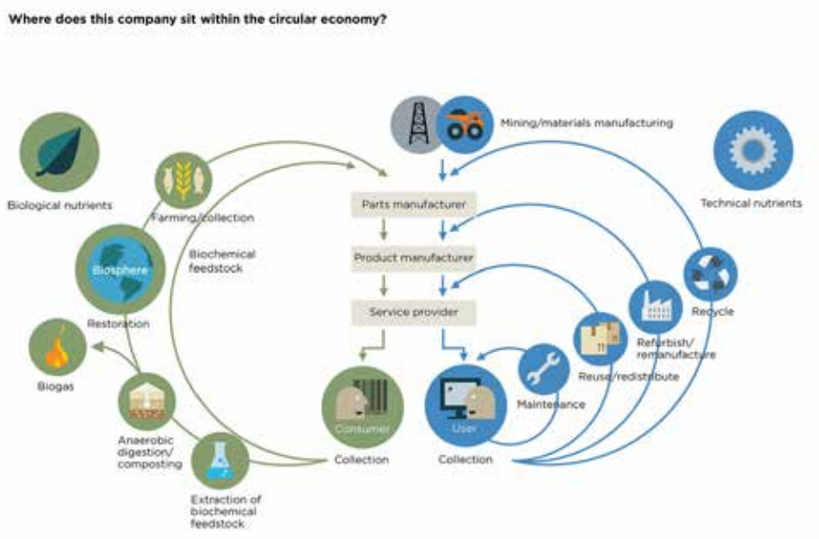


Figure 2. Material flow diagram (Ellen MacArthur's Foundation)

To make the loops as closed as possible, the concept of ownership needs to change. Instead of selling goods, producers and manufacturers would sell their goods as services. In other words, customers would pay for the use of products. As an example, we would buy hours of lighting service, not bulbs and electricity, or lighting devices. Similarly, we would buy mileage of transportation service, not necessarily a car, which stays idle most of the time. This way, the producers remain the owners of goods. Consequently, the impetus is to develop durable and long-lasting products that are designed to be easily upgraded, dismantled, repaired or remanufactured, in order to secure the profit and preserve resources essential for the business. Simultaneously, consumers gain better, high-tech and good-quality products and services for use. By becoming service providers, producers could extend their services to maintenance and repair, which would boost regional employment.

The smart design and the inner loops (reuse and refurbish) give producers an opportunity to remarket products and extend the customer base to the secondary markets, offering quality reprocessed products at affordable prices.

Drivers, challenges, enablers

In the empirical part of the research six in-depth interviews were done. The respondents found, similarly to the Ellen MacArthur's Foundation and other sources, among the biggest drivers (1) the scarcity and volatile prices of natural resources, (2) the potential for new businesses and thus job growth, followed by (3) the boom of EU legislation and support. Also, (4) the shift in some consumers' behaviour and their orientation from goods' ownership towards services was regarded as important.

At the same time, some of the drivers were seen as challenges or obstacles of the change towards the new economic model, such as maintaining the status quo of material possessions. In some cultures, this represents a cultural and psychological stress. Ownership is connected with personal or group identity and, therefore, this undisputed norm should be addressed delicately. Maybe, it is time to change the norms, but without forerunners it is not possible.

According to the respondents, the biggest challenge is to change people's attitude and way of thinking. One of the respondents quoted aptly: "It is easier to run the business the usual way." During the past years, many new terms and definitions have arisen. Some are wrongly used interchangeably and that creates confusion among the general public. Based on the interviews, this is also the case of circular economy, leading to circular economy being another synonym to recycling or waste management.

The lack of financial and legislation support of various forms was regarded as a barrier. The disharmonized legislation is one of the obstacles; as an example, the status of waste/ product was pointed out. To complement the respondents' view, the literature review revealed that the current challenges also include missing targets for reuse and remanufacture, reliable information and quality standards for secondary materials. The lack of quality standards partly explains why producers prefer virgin materials to secondary materials. Also, it is a fact that due to available technologies these secondary materials are often more expensive than virgin raw materials.

The respondents also stressed the importance of the general awareness and innovation needed to develop concepts convenient enough for consumers to make the change happen, as well as to create the infrastructure for producers and manufacturers.

Limitation of the model

When debating on the limitations of the model, the vast majority of the interviewees agreed that the limits are in our heads, in people's minds; the current system and available technologies also restrain the transition. Supporting legislation plays a role too, as the current legislation is built for the linear system, in line with the theoretical findings.

The mindset of all the players needs to be changed. Consumers need to see the benefit in the availability of quality products and service to use, which they might not have been able to reach so far. On the other hand, there is a risk of the rebound effect, since more products and services will be used as they will become available to more people. Also, the mindset shift includes consumers' perception of secondary or reprocessed products, as they might represent a social barrier, something of a lower quality.

Producers and manufacturers need to acknowledge that the model offers many

Figure 3. Material recycling

business opportunities, even though some of the companies might no longer exist if they are not willing to adapt to the new conditions. The current policy of any enterprise, to sell more goods fast, needs to be transformed into eco-effective and eco-efficient products and services that last long. The core of the business remains the same, to make profit and satisfy customers. On top of that, the aim is to protect the environment by designing products smartly.

The transition from a product-owning model to a result- or service-oriented model is not easy. From the producers, it requires heavy pre-financing of goods. The infrastructure for maintenance and repair needs to be organized and attention also has to be paid to the various systems of goods acquisition and collection back from the consumers/users. In many cases, the volumes might be rather small, so a sophisticated system is required.

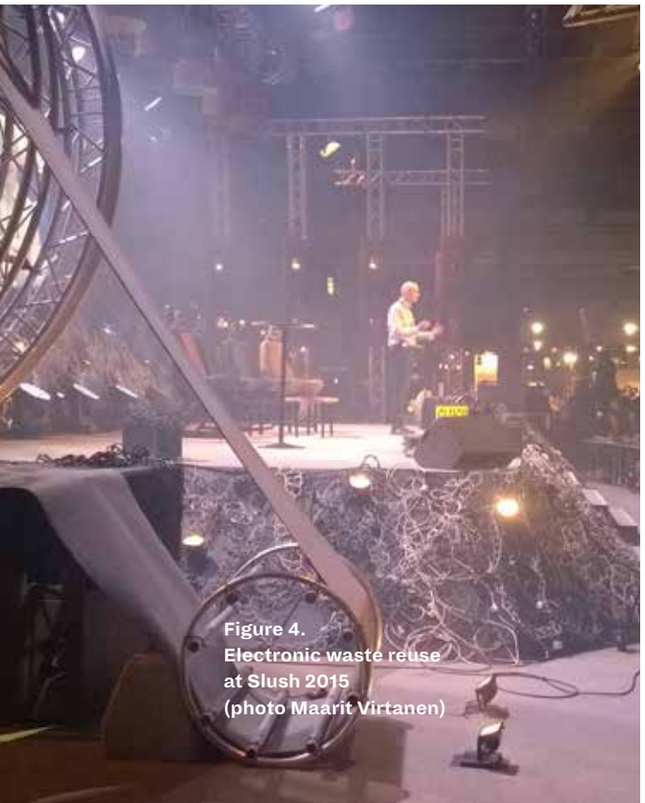


Figure 4.
Electronic waste reuse at Slush 2015 (photo Maarit Virtanen)

Findings

Based on the interviews, we rather concentrate on the outer loops, such as recycling and waste management. However, when the discussions come to the point of recycling, it is actually too late, as we let waste occur. It means that we have literally wasted the great material value through many of the present recycling processes. In most of the cases we talk about downcycling, not upcycling, as the products are, in most of the cases, shredded and often mixed with materials, which were originally not specifically designed to be recycled. Recycling has its significant place in the circular system, but it is only a small fragment and the weakest loop in terms of preserving the material value. By focusing on recycling and waste management, we approach the resource challenge backwards, from the end.

Currently, the attention is also on the repair and reuse loops. This is a huge step forward, but it is still a backward approach to the challenge.

Instead, the spotlight should be on product design, the starting point of the resource challenge. Thanks to smart product design and co-design, the overall life-cycle impact can be influenced and waste creation prevented. The dismantling, repeated reuse and remanufacturing of the product, along with its durability, eco-effectiveness and eco-efficiency are the foundations of smart design, before the product is born. The following loops would then be tailored to the novel designs.

It is similar to planning a dinner for your guests with special diets or allergies. Which approach is better? Either preparing the menu according to the guests' food restrictions and considering the ingredients and their potential impact, or not paying attention to the preparation phase and serving any kind of food and trying to deal with the reactions, putting the guests' health at stake, and wasting the time, energy and resources while making this menu?

However, it is necessary to see the holistic view, where all the loops and activities have their role and place. It is important to remember that these flows are not always circular. The circularity is limited by our knowledge and technological solutions at the given point of time. Moreover, it is caused by the system dynamics, which are evolving, in the same way as humankind. Therefore, we need continuous development and innovation of our solutions.

Conclusions

A circular economy offers us a novel approach to our untenable consumption of natural resources. The concept presents immense opportunities by embracing the economic, environmental and societal needs. Though its principles are rather simple, it has enormous implications for our living and consuming patterns, for our values and way of thinking, and even doing business. Based on the research, the biggest limitation is in people's minds. The transition requires social innovation, technological breakthroughs due to the currently limiting solutions, and redesigning the entire system level. Certain obstacles relate also to the economical interest groups involved in the present status quo of natural resources extraction, production, consumption, and recycling.

The implementation of circular economy is a dramatic change, which would not happen overnight. A lot needs to be done, a lot needs to be thought, and a lot needs to be communicated. The change is happening already. Companies are changing from entirely ("poor") product based businesses to service oriented in many business areas, such as furniture, cars, construction, roads, chemicals etc.

All the players ought to be engaged in the process; not only producers and manufacturers, but also consumers, municipalities, scholars, organizations and the general public. The change can be successful only if the knowledge, experiences and values are shared, requiring mutual cooperation and collaboration. Furthermore, a combination of an array of policy instruments, economic tools and various factors and mechanisms, the 'Support', together have a synergy effect on the transition.

To make the transition happen, the success lies in raising public awareness of the circular economy principles, the 'What', but most importantly, the reasons for the change, the 'Why', in order to get people to strive towards the same goal. Public awareness together with the 'Support' of various enablers creates the stimulating environment and food for innovative thinking and solutions of 'How' to accomplish the transformational mission.

The future is circular!

References

Circle Economy. 2015.
FAQ. Circle Economy. The Netherlands [referenced 24 July 2015].
Available at: http://www.circle-economy.com/library/faq/#toggle-id-3.

Circular Economy: an Introduction. 2015.
Delft University of Technology. edX online MOOC course.

Ellen MacArthur Foundation. 2013.
The Circular Model - Brief History and Schools of Thought [referenced 17 July 2015]. Available at: http://www.ellenmacarthurfoundation.org/circular-economy/circular-economy/the-circular-model-brief-history-and-schools-of-thought.

Ellen MacArthur Foundation. 2015.
FAQ's [referenced 16 July 2015]. Available at: http://www.ellenmacarthurfoundation.org/about/faqs.pdf.

McDonough, W. & Braungart, M. 2002.
Cradle to Cradle: Remaking the Way We Make Things. North Point Press. New York, USA.

Medkova, K. 2015.
Towards Circular Economy: EU, Finland and Lahti Region Perspectives [referenced 11.11.2015].
Bachelor's Thesis. Available at: http://www.urn.fi/URN:NBN:fi:amk-2015110916096

Stahel, W. 2012.
Walter Stahel on the Performance Economy. Ellen MacArthur Foundation [referenced 20 July 2015]. Available at: https://www.youtube.com/watch?t=222&v=PhJ-YZwDAVo.

Towards the Circular Economy Vol. 1: Economic and Business Rationale for an Accelerated Transition. 2012. Ellen MacArthur Foundation. 2013 [referenced 20 July 2015]. Available at: http://www.ellenmacarthurfoundation.org/business/reports/ce2012.

World Population Balance. 2014.
Current Population is Three Times the Sustainable Level [referenced 24 August 2015]. Available at: http://www.worldpopulationbalance.org/3_times_sustainable.

Noora Nylander

Quick Prototyping in Packaging Design – How to Understand Users and New Ecodesign Solutions

Why to quick prototype?

According to the IDEO company, prototyping is a good way to work towards a design goal. The main reason for prototyping is to ask questions and create discussion. Prototyping is also a good way to test abstract design ideas, especially when we are talking about sustainable strategies, which can sound abstract at first. According to OKALA's sustainable strategy wheel (Figure 1), some ways to create sustainable design are for example designing to increase product lifetime and to fulfil users' desire to keep products longer. Sustainable design can also involve strategies which for example consider product service combinations instead of traditional product design, design for disassembly and maintenance, and using innovations which support sustainability in some way. This article presents examples of prototyping to get user data as well as prototyping to test design ideas that convey sustainable strategies of designing for product life time and innovation.

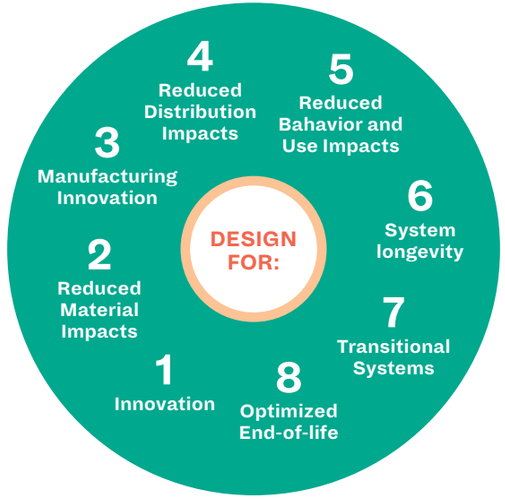


Figure 1. Eco design strategy wheel (OKALA 2015)

Figure 2. User testing situation in packaging design of a user-centred design project. Case shampoo packaging and target users seniors. Students of packaging design year group 2014. (Nylander 2015)

Quick prototyping in packaging design

Quick prototyping is an act of experimentation which forces the designer to ask questions. One can prototype almost anything, as IDEO suggests in their Zine magazine by describing prototypes of a restaurant concept and testing different computer mouse designs and a magazine layout. A prototype can be made on many levels – it can be a series of pencil drawings to test an interface of a software system or a service activity in a hospital emergency room. In addition, it can be a quick version of a product or system, or comparison of different products which contain features that do not exist yet. A key aspect in quick prototyping is to make it as cheap, fast and rough as possible. Especially when testing with users, the less fine-tuned the testing prototype is, the easier it is for users to evaluate and rate it.

Fiber-based materials like cardboard are a good, easy-to-build and cost effective way to prototype packaging design. Thus, the traditional part of packaging design, construction design, includes several test versions of the construction. Following this prototyping idea, Boylston suggests that one important part of sustainable packaging design is to prototype the structures and combinations of packaging systems. Writing for packaging graphic designers, Boylston says that sustainable packaging design should involve prototyping of the whole packaging concept.

For years, the Packaging Design and Branding Department of the Institute of Design of Lahti UAS has been testing different ways

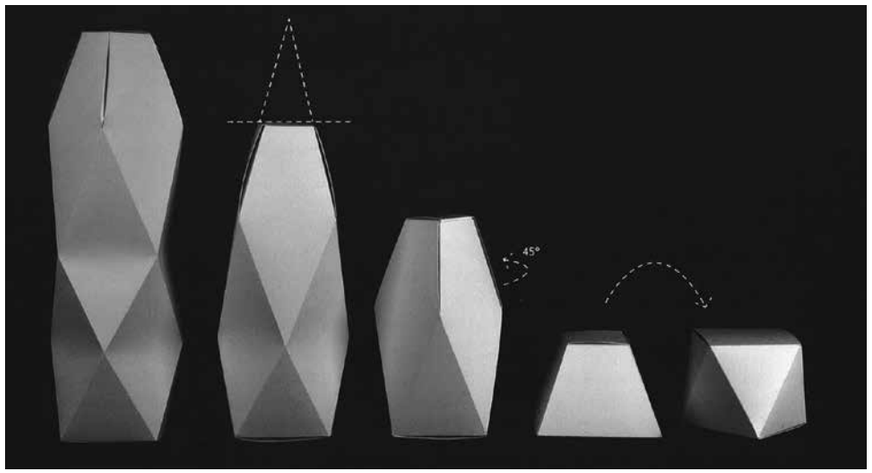


Figure 3. Bottle prototype using cardboard structures (Hokkanen, 2012 according to Jackson 2012)

to use quick prototyping in their education. Some methods like paper and cardboard constructions are quite traditional ways to make tests. In addition, the cardboard and paper models are also good ways to test forms that can be transformed into other packaging systems in later phases of design, as Jackson suggests in his studies about creative structural packaging design (Figure 3).

When considering sustainable packaging design, testing sometimes becomes more complex. From the sustainability point of view, packaging development includes all the steps of the system life cycle, but packaging design is also a tool to create sustainable user experience. Earlier we discussed testing for example software interfaces, but packaging as a whole system can be seen as an interface for using the product. Packaging is a great communicator, which can convey more tangible information as well as hidden messages for the user. Here packaging can be seen both as a user interface and a functional product – so the question is how, at the same time, we can test the functionality of the system and the ways the user communicates with the system (Figure 4).

In Figure 2, in a user-centred shampoo packaging project, the students tested these two separately – functionality and visuals of the packaging. Additionally, the students tested the existing packaging mechanism and also new conceptual ideas. The problem with testing the

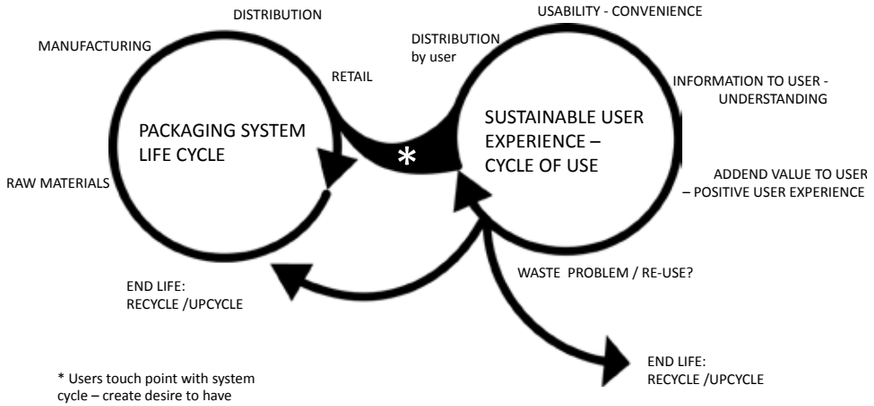


Figure 4. Sustainable system and user experience circle (Nylander 2013)

packaging is that users, when interviewed, tend to wander to talk about their personal taste of the familiar systems of packaging, and they compare the existing world too much with new ideas. Observing how they behave in a real situation would be the best way to gain hidden user data.

Testing the system – Design strategy for increasing product life time – case ”Herbs for Health”

Herbs for Health is a packaging design project by Duncan Anderson, which started with the idea to design for increasing product life time. The project discusses how to maintain fresh herbs sold in supermarkets for a longer time; growing herbs in the Nordic region is quite energy consuming and possibilities to keep them alive longer would add value to the product.

Firstly, Anderson tested different self-watering systems for plants to gain knowledge about system functionality. After that he designed a packaging system which contains a self- watering system for the herbs.

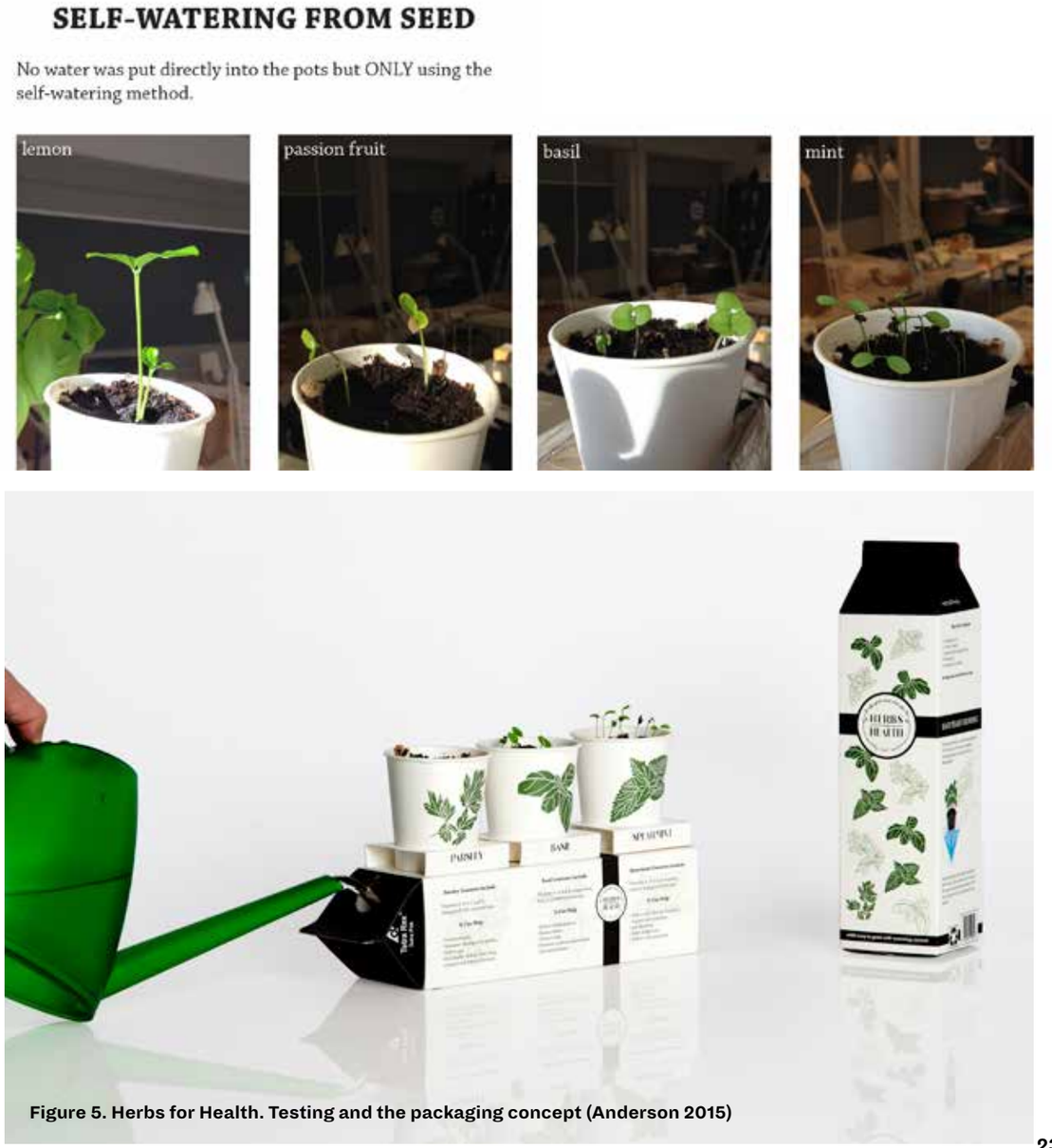
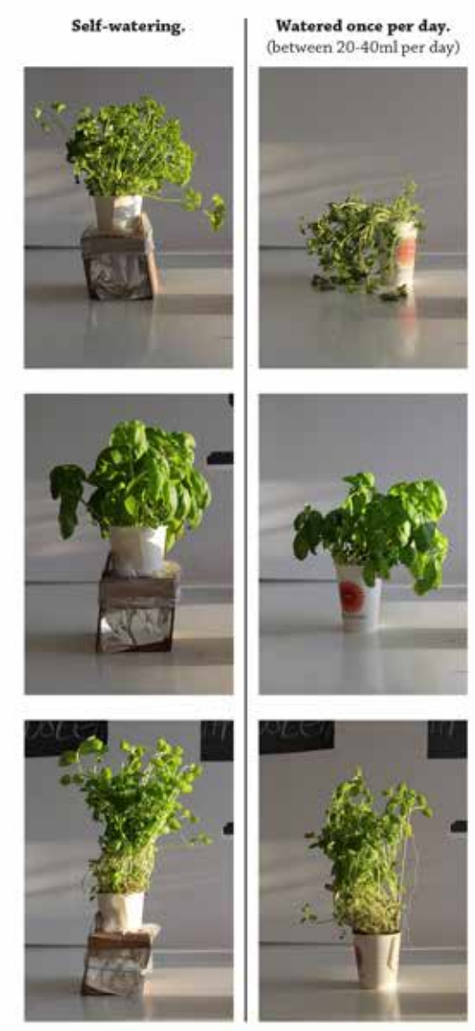


Figure 5. Herbs for Health. Testing and the packaging concept (Anderson 2015)



Design strategy for using new innovation - intelligent materials – case ”Taste of RGB”

Tomorrow Machine is a Sweden-based design studio, which specializes in packaging and food concepts. Their vision is to create an understanding between science and creative ideas for the future. Thus, they work with new technologies and intelligent materials in their design. The Taste of RGB is a packaging design project by students Kasperi Salovaara and Kevin Hytönen, which is based on Tomorrow Machine’s ideas of edible and self-destructing packaging. In their design the packaging material has the same life cycle as the product it contains. In the ”This too shall pass” series the packaging materials are biodegradable beeswax and caramelized sugar. The concepts also play with the idea of the material starting to wither when the packaging is opened, for example a biobased material solving in water or materials peeling like fruit peels. All these tests also include the sustainable design idea of bio-mimicry.

In Taste of RGB the beeswax protects the actual packaging material, which is made out of caramelized sugar. The protective barrier of beeswax behaves like traditional foldable packaging material, which creates familiarity in using the new innovation as a packaging material. Students built prototypes from beeswax in their own kitchen to test the functionality of the new materials.

Figure 6. Testing the project Taste of RGB. (Hytönen & Salovaara 2015)

Development targets of packaging design prototyping

Since packaging design as a user experience is also very situation-based, a good development goal would be to test users with the role play technique. Thus, designers would stage the situation and environment where the packaging should be used in real life and observe how the user behaves and understands the functionality of the packaging as a product and also the packaging system as an interface. Observing how systems and new innovations are understood and then owned by users is crucial, to get new sustainable ideas into the daily life.

References

Anderson, D. 2015.
Herbs for Health project

Boylston, S. 2009.
Sustainable packaging design. London: Laurence King Publishing Ltd.

Hokkanen, J. 2012.
Burn - energy drink packaging project. Course assignment. Lahti UAS, Institute of Design, Packaging Design.

Hytönen, K. & Salovaara, K. 2015,
Taste of RGB project. Course assignment. Lahti UAS, Institute of Design, Packaging Design.

IDEO. 2015.
Zine magazine: You can prototype anything [referenced 30.9. 2015].
Available at: http://zine.ideo.com

Jackson, P. 2012.
Structural packaging: design your own boxes and 3-D forms. London: Laurence King Publishing Ltd.

Okala practioner guide. 2014.
IDSA [referenced 9.10.2014]. Available at: http://www.okala.net/index.html

Tomorrow machine design studio: This too shall pass-project. 2015. [referenced 9.10.2015]. Available at: http://tomorrowmachine.se/#present

Maarit Virtanen

Lahti2017 - Not for 10 Days but for the Next 100 Years

Lahti will host the historical seventh Nordic World Ski Championships in 2017. The year 2017 is also the centenary of Finland's independence, and the games will be one of the main celebrations of the year. The aim is to organise an event where everybody feels at home, and which leaves a sustainable legacy – also on the environment.

Environmental management at Lahti2017, and the preceding Lahti Ski Games 2016, is based on EcoCompass (Ekokompassi), an environmental management system designed for small and medium-sized enterprises and events. EcoCompass is used at several major events like Flow Festival, Finlandia Trophy and World Gymnaestrada 2015. The aim in Lahti is to enhance environmental performance for the 2016 pre-world championships, and maintain the higher standards for 2017 and beyond. The main emphasis of environmental issues is on energy efficiency, resource efficiency, sustainable transportation and environmental awareness. Active communication about environmental issues and cooperation with, for example, schools and companies enable the raising of environmental awareness.

Lahti Events, which is the ski games organiser, and Lahti University of Applied Sciences have a cooperation agreement that includes environmental issues as well as broad collaboration on, among other things, volunteer services and service design. Lahti Ski Games and Lahti2017 are also pilot events for a Lahti UAS project called REISKA: New Business through Resource Efficiency. One of the work packages of the REISKA project focuses on events, with two main aims. The first is to create an online tool for event organisers for checking their material flows and identifying areas for improvement. The second aim is to improve resource efficiency at pilot events and to find business opportunities related to resource use.

At Lahti2017, the main emphasis of material efficiency is on catering, venue dressing and temporary construction. These are areas in which the procurement volume is considerable, and where it is possible to influence the scale of environmental impacts. Catering is an area where the commitment of partners is central, as the services are procured from various companies. Procurement is monitored as part of the environmental management programme. Cooperation with the Lahti2017 presenting sponsor, Stora Enso, enables the use of sustainable materials like re-board and renewable packaging in, for example, temporary construction and catering.

A basic but essential part of material use is making sure that waste is sorted and recycled properly, which is often challenging at events. Cooperation with Lahti UAS includes planning of waste management service for events. The service will be piloted at Lahti Ski Games 2016 and taken into full use at Lahti2017. The service includes waste collection structures, visual signs, and planning the waste collection chain. Wood technology students plan the physical structures, which are made of wood to honour the Finnish independence celebration. The waste collection modules planned are flexible, and can be used at different types of events or even as permanent structures. A central part of the work is to plan visual sorting instructions suitable for events. Lahti UAS environmental technology students also assist in making the waste management plan for the games.

One of Lahti UAS students, Päivi Liukkonen, is doing her final thesis on the use of textiles in event venue dressing. In her work, she has two focuses. Firstly, she examines the choice of outdoor textile materials (flags, banderols, banners etc.) from the resource efficiency point of view. The work deals with the choice

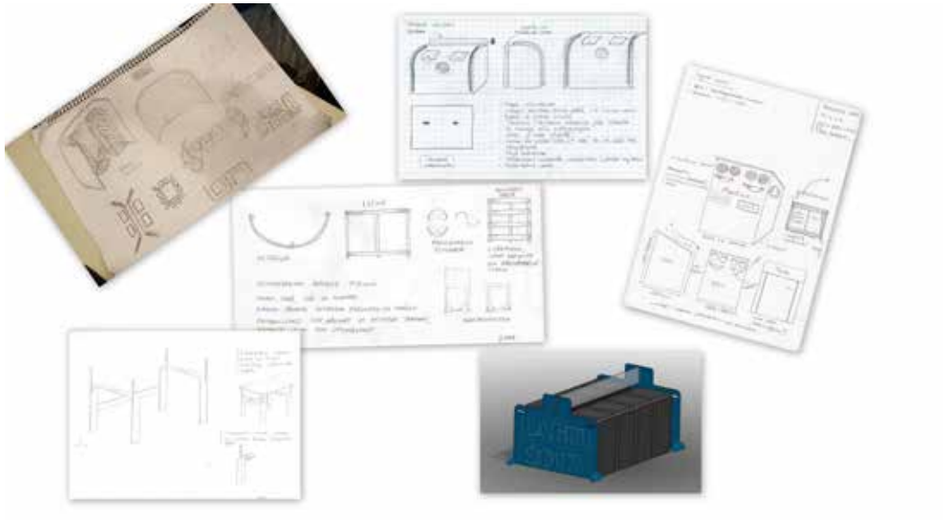


Figure 1. Waste collection structures designed at Lahti UAS (photo Maarit Virtanen)

of materials and their reuse and recycling possibilities. One point is also to find out how well textiles can be adapted for different events: for example, can materials used at Lahti Ski Games 2016 be modified to match the visual appearance of Lahti2017. Secondly, she studies the use of recycled textiles indoors and specifically the fire hazard regulations related to their use.

The Lahti Sports Centre is undergoing large renovations to upgrade the old premises for the ski games and other events, as well as for recreational activities. These renovations also improve energy efficiency especially in the office premises in the main stadium building. The City of Lahti implements the energy efficiency improvements through an ESCO agreement, in which the investments are made with external funding. The investments are paid back through the cost savings achieved through reduced energy consumption. The targeted energy savings at the planning stage were 240 MW of electricity and 905 MW of heat annually.

Making artificial snow is an activity which consumes considerable amounts of both energy and water. Besides the ski games, artificial snow is required for recreational purposes. The artificial snow system by the Sports Centre is being renewed, which means that, in the future, water from the nearby Lake Vesijärvi will be used, instead of groundwater, which is used by the old system. When finalised, the new system will considerably reduce the use of vehicles to transport snow, because the renewed system can utilise snow machines along the ski tracks. The capacity of the system will also be increased, to meet the requirements for 2017 and to provide better recreational facilities for skiers.

Renewable energy will also be introduced in the Sports Centre through a solar PV system with panels located on the roof of the main stadium building. The capacity of the solar panels is 120 KW and they will be installed in the spring 2016. In addition, the City of Lahti is implementing an interesting pilot on intelligent street lighting on the route between the Lahti Harbour and the Sports Centre. Intelligent lighting systems combine information technology and electronics, enabling, among other things, energy savings and more purposeful lighting. Intelligent systems can also be used for different kinds of guiding and informational purposes based on data gathered from the urban environment.

Figure 2. Renovations at the Lahti Sports Centre (photo Tami Kiuru)

Sustainable transportation is an important part of environmental work, because transportation often causes most of the emissions of an event. Lahti is favourably located with good train and bus connections from Helsinki. The Sports Centre is also close to the city centre, which reduces the need for private cars. However, different kinds of mobility management activities are needed to promote sustainable transportation. These can include, for example, joint tickets to public transportation, free rides or reduced rates for volunteers in local buses, facilities for cyclists, and services for pedestrians.

Overall, Lahti2017 is a unique event, which provides excellent opportunities to promote Finnish Cleantech and environmental know-how in different areas. Cooperation with companies and other stakeholders offers possibilities to introduce innovative solutions in the environmental sector.

References

Arola, J. Building Manager, City of Lahti. Personal communication 29.5.2015.

Ekokompassi tapahtuma [referenced 13.10.2015].
Available at: http://www.ekokompassi.fi/tapahtumat/

Lahti2017 [referenced 13 October 2015].
Available at: http://lahti2017.fi/

Tekes. 2015.
Älykkäästi ohjatusta valaistuksesta tehdään Suomelle bisnestä [referenced 13.10.2015].
Available at: http://tori.tekes.fi/2015/10/05/alykkaasti-ohjatusta-valaistuksesta-tehdaan-suomelle-bisnesta/

Marianne Matilainen, Jarno Mäkelä, Matias Mesiä, Ekaterina Ruotsalainen, Janne Koistinen, Minni Aalto and Heejung Park

Green ICT in Small and Medium Sized Companies

Information and communication technology (ICT) is playing a big and ever increasing role all over the world, both in business and in people's private lives. This increasing role brings higher energy consumption and significant carbon dioxide emissions. Today ICT releases as much CO^2 into the atmosphere as nearly 320 million cars, according to the calculations by consulting firm A.T. Kearny.

In business organizations, Green ICT means all solutions that save energy. It includes hardware, software, services, employee behaviour, recycling and plans for the future. You cannot purchase Green ICT directly, but by making intelligent solutions and planning the future a company can become more energy efficient. The benefits of Green ICT are shown in Figure 1.

Virtualization is an example of how Green ICT can benefit companies with a large amount of IT infrastructure. With virtualization you can run multiple computers or operating systems on only one computer. By virtualization you can access programs in different networks that you would not be able to use from your local computer.

Virtualization is also a way to build test environments. When a company plans to upgrade their production environment, they can test it with virtualization, requiring less

Environment/society	+ Lower CO_2 emissions + Reduced resource consumption + Compliance with legal requirements (in the future)
Companies	+ Reduced energy costs + Reduced operating costs of data centers + Less hardware needed

Employees	Capital market	Customers	Public
+ Increased employee satisfaction + Greater loyalty + Easier recruitment	+ Improved ratings + Higher share price + Greater company value	+ Greater customer loyalty + Appeal to new customer groups + Greater customer satisfaction	+ Improved image + Rounded-out CSR strategy + Greater brand value

Figure 1. Benefits from Green ICT (T-Systems, 2009)

hardware. It is always easier and cheaper to test and develop with fewer computers and servers. Also, if the computer used to access virtualized services breaks down, it does not affect the virtualized environment. Damage is only caused if the server where the data is located breaks down. However, in a production environment data is always duplicated, so the risk is minimal.

Cloud services allow companies to build their infrastructure in a cloud server of their own or in the server provided by some other company. The company saves in server capacity and can externalize its IT services to cloud. Usually cloud services are also easy to use even for employees that do not have so good IT skills. Examples of cloud services in everyday life are Microsoft's Office 365, Apple iCloud and VDI (Virtual Desktop Infrastructure).

Green ICT can be very cost-effective and affect business growth by decreasing infrastructure costs. Data centres are one of the most significant consumers of energy in the IT sector. In addition to this, the maintenance of data centre infrastructure requires a lot of financial resources and expertise, which may be problematic for smaller companies. In this context, virtualization of data centres and servers would be preferable.

Research

In 2014, a group of students made a questionnaire with 32 questions for 13 companies in Lahti. The companies were small and medium sized companies and the goal was to look at their energy efficiency from the information and communication technology points of view.

The questions were divided into six subdivisions. The questions dealt with general background, hardware, purchase of hardware, employees, recycling, and future plans. In the general part there were questions related to electricity, virtualization, cloud services, property and printing. There was some variation in the questionnaire, because the questions were different for different companies. Questionnaire results

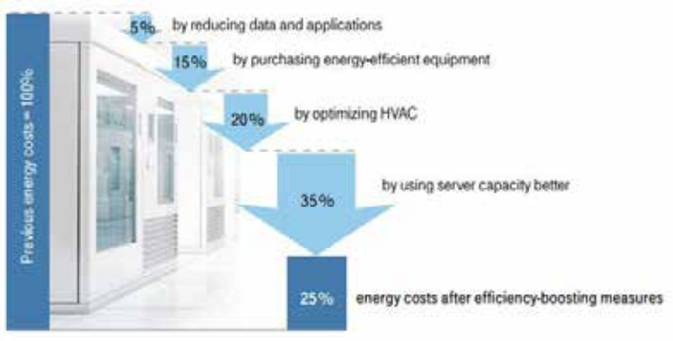


Figure 2. Green ICT process (Deutsche Energie Agentur, 2009)

were used to suggest concrete measures to improve the environmental performance of the companies. Below are examples of the current situation of the companies and suggestions for improvements.

A photo studio

At the photo studio studied, it was not possible to use virtualization, cloud services or remote working. Machines used need to be powerful and be able to print high quality pictures. This consumes a lot of energy and resources. The company's energy consumption is quite high, but they repair, sell onwards and recycle devices as much as they can. Also, they use LED lights and switch off lights and machines when closing the shop. A life-cycle analysis is made when obtaining new equipment and the equipment is maintained regularly.

The students recommended to the company that when obtaining new equipment, they could check energy consumption estimates and energy labelling. The company could also get a more economical car, for example a hybrid, for common use. In addition, the company could consider using green energy, and purchase energy produced by wind, water or solar power.

A jeweler's

The company tries to save energy in many ways, and has trained their employees on energy efficiency and its benefits. They have adopted the BYOD (Bring Your Own Device: one device is used for both official and personal purposes) system and make a life-cycle analysis when they buy new equipment. Devices are maintained regularly. When a machine breaks down, they first try to fix it by themselves and then recycle it through a recycle centre or a second-hand shop. The company wants to improve energy efficiency in the future. A daily example of their basic energy saving is that they keep the lights off when they do not use the coffee room.

Although the company has already thought about environmental issues, there is still room for improvements. The company used, for example, cloud or virtualization systems together with the already started BYOD. The BYOD system can cut down the costs of devices and save energy. If the company could use virtualization, it could cut down the need for computer capacity and the load in servers. As server efficiency would improve, the company would not need so many computers. With the cloud system, this jeweler's store could share systems and save resources. The company could also utilize energy labelling when buying new devices.

An electric service company

Currently the company does not think about energy efficiency. The only thing that is done consciously is turning off the lights when there is nobody in the room. Energy efficiency is not considered when buying devices, but the decision is based on the properties and the price of the product. It is assumed that all devices can be recycled, and no life-cycle analysis is done when buying the device, except that it should last for a few years. Employees are not advised about energy efficiency nor its benefits. The company is not ready to organize training for its

Figure 3. Jeweler's

Figure 4. Cloud computing

employees. Remote work is not a possibility in the company and employees do not really have a possibility to travel to work on foot or by bike as they live so far. The company vehicles run on diesel and emissions are not considered when making new purchases.

The students suggested that energy efficiency should be taken as a criterion when purchasing electrical devices or new vehicles, and devices should have properties that allow the devices to be turned off at certain hours or when they are not used. It could lower the costs and the company could sell devices to customers with the knowledge about energy saving, and with that the customers could also be more energy efficient.

Analysis

The company survey showed that a lot of companies were conscious of ways of saving money and being more energy efficient. In the hardware area, companies were replacing older energy consuming devices with smaller and more energy efficient hardware such as laptops and tablets. The companies that used data centres were aware of outsourcing opportunity of data centres and they were thinking about it, but had not yet managed to implement it. Companies were not using the BYOD (Bring Your Own Device) method very widely.

Only two out of thirteen companies surveyed were using virtualization technology, but the companies were conscious of virtualization. In small and medium sized companies there is no need for virtualization if there are only a handful of computers. When purchasing hardware, companies bought devices that were the cheapest. Only a small group of companies had other criteria than price. Also, most companies did not know if their devices met the EEE standard and had not analysed their life cycle. Companies were not conscious of the source of the electricity they used.

Employee questions were made to get information about how companies encourage their employees to act in an environmentally friendly way. A small majority of the companies were guiding their employees on how to work and act in a more environmentally friendly way. Most did not support their employees on sustainable transportation, like using public transportation or bicycle. One third already supported remote working days and all were positive about increasing the amount of remote working.

Recycling was in order in the companies and nearly all were using recycling channels for their old IT devices. The rest of the companies told that they reused their devices or donated them to better use. Half of the companies told that they maintain their own computers and other devices, if there is some kind of problem with them.

The questions about future plans dealt with companies' policies on energy efficiency and car use. Two companies were exploring ways to be more energy efficient in the future and only one third of the companies had goals to improve energy efficiency. Companies used only diesel vehicles with no hybrid or electric vehicles. Results show that companies were not very motivated in Green ICT and the main priority for them is to make profit in any way.

Conclusions

Though the adoption of ICT is growing worldwide, which in turn increases the energy used by hardware and software and causes a huge amount of electronic waste, it is important to understand the great positive potential of ICT. With effective power management, using new technologies such as virtualization and cloud computing, green ICT could suggest environmental advantages that exceed the global footprint of ICT itself. Adopting technologies of Green ICT is favourable for all kinds of companies, but especially small and medium sized enterprises could benefit a lot from becoming "greener". First of all, Green ICT helps to save a company's money through reducing its energy use. The main directions in improving energy efficiency are cloud computing, desktop virtualization, server consolidation and virtualization, and storage virtualization on the one hand, and effective power management of desktop infrastructure on the other.

The adoption of Green ICT could be in some ways problematic for small and medium sized enterprises, which have limited equipment and human resources. In spite of these reasons, and also because of them, small and medium sized enterprises can and must move towards greener technologies. When shifting to cloud, data centre and desktop infrastructure virtualization needs extra investments, but these technologies will help to save on hardware and expertise and reduce energy consumption in the future.

References

Amazon Web Services. 2013.
What is Cloud Computing? [referenced 25.102015]. Available at: http://aws.amazon.com/what-is-cloud-computing/

Cura, K. & Virtanen, M. (eds). 2014.
Lahti Cleantech Annual Review Vol.1. Lahti University of Applied Sciences. Series C Articles, reports and other current publications, part 168.

Deutsche Energie Agentur. 2009.
Energy-Efficient IT Equipment at the Workplace: Potential, Purchasing and Use.

Kuisma, N. 2015.
Green ICT PK-yrityksissä: Ympäristötehokkuuden kysely.
Bachelor's Thesis in Telecommunications Technology. Lahti University of Applied Sciences.

T-Systems International GmbH. 2009.
White Paper Green ICT. The Greening of Business [referenced 25.10.2015]. Available at: http://www.ictliteracy.info/rf.pdf/T-SystemsWhitePaper_Green-ICT.pdf

Vmware. 2015.
Virtualization [referenced 25.10.2015]. Available at: http://www.vmware.com/virtualization/overview.html

Ilkka Tarvainen and Mika Vanhanen

Motivational Workshops for Vocational Students to Continue Studies at a Higher Level

Introduction

The objective of the motivational workshops project is to motivate students of wood technology at the vocational level to continue their studies at the bachelor level. The aim is to provide them with better chances to work in the future, when work requiring lower education gets outsourced or replaced by machines.

Currently the problem in vocational schools in Finland, Hungary and Slovakia is that students are not motivated to continue their studies into a higher level. The biggest reasons are lack of knowledge and low self-confidence. Vocational school students have little knowledge of the possibilities of bachelor-level studies, which are usually not advertised nor emphasized during vocational studies. Also, students have low self-confidence for higher level working requirements. Only a small number of students from this project`s partner schools continue their studies to reach the qualifications, which will soon be required to meet the requirements of today's labour market. High quality project tasks and close cooperation between vocational and bachelor-level students in international projects has been limited, at least in the sector of wood technology. This is a problem, because the mechanical wood industry is a very international sector but it has hardly any projects between different educational levels.

The motivational workshop project is funded by ERASMUS+ through national agency CIMO (Kansainvälisen liikkuvuuden ja yhteistyön keskus) and is implemented during the years 2014 – 2016.

Workshops

Cooperation is organized in the form of four workshops and online seminars, which are organized in each partner country. The workshops are attended by at least three students from each partner school, along with a teacher or expert. Online seminars allow a larger number of members to get involved in the project. The seminars are taken on video and the videos are saved, edited and shared within the partner consortium.

The workshops are arranged at about 6-month intervals. The students work together during the workshop days. The first workshop was arranged at the end of January 2015 in Lahti Finland and the second workshop was

arranged in May 2015 in Zvolen Slovakia. The third workshop will be arranged during the second half of 2015 in Sopron Hungary and the last workshop will be arranged during the first half of 2016 in Lahti Finland. The main idea of these sessions is to make the students aware of how education is organized abroad, how to act with students from other countries, and to offer students a chance to participate in high-level research on a new technology which allows many prospects. This all aims to motivate students of vocational and bachelor levels to expand their knowledge and capabilities in the sector of wood technology as well as in the area of operational skills, such as group working and language skills.

Wood is one of the best natural and renewable raw-materials on earth and will be the material of the future, which requires a lot of experts to create new innovations. This project's activities are aimed to support motivational factors in order to wake up students' interest in studies at the bachelor level. Activities are planned, scheduled and executed so that in every workshop students get to know the idea of the task, how it works and why it is important from the point of view of the next task to complete. Tasks are closely related to product and manufacturing development processes, which are common tasks in the labour market of specialist fields. Methods are applied in workshops, which are the main activities in this project. Workshops include tasks in groups (which involve students from both vocational and bachelor degree levels) like mind-mapping, planning, attending lectures, doing practical work in a laboratory and reporting on the results that were achieved during the workshop.

Results are presented and reported and everything is shared during the project within the cooperation consortium and with the other industrial partners related to the project's cooperation partner organizations.

Technology

The technology studied in the workshops is 3D Hot Forming (Solidiwood®), which is a new technology for further processing of wood, offering new kinds of innovation possibilities. It can be applied to produce many kinds of further processed timber products and it is not limited by wood species. The technology will decrease the consumption of wood material and basic weaknesses when manufacturing the end products. It can achieve permanent advantages, such as products with better properties, smaller consumption of timber raw material and more cost effective production.

The basic idea of 3D Hot Forming is simple. Wood is pressed under heat and pressure into a selected form by using steel moulds. Figure 1 below shows the difference between the new technology and the traditional way.

Products so far produced by 3D Hot Forming technology are e.g. terrace flooring (including surface treatment), I-beams and technical wooden beams.

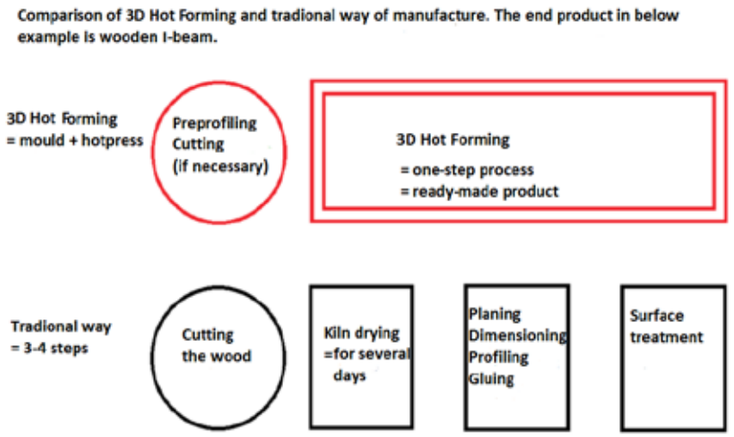


Figure 1. Comparison of 3D Hot Forming technology and traditional processing (Tarvainen 2015)

First workshop in Lahti, Finland

The aim of the project was to investigate the 3D Hot Forming process. By evaluating the process and the results, students understood better how to manufacture the chosen products for terrace flooring panels. This method is based on the specified amount of pressure and temperature, in a specified time.

The moisture content, dimensions, weight and density of the samples were measured both before and after 3D Hot Forming, and photos were taken of the samples. The 3D hot pressing procedure for pine wood was on average as follows: 1st step - hot pressing 15-30 min. 15 bar (temperature 160 C); 2nd step - hot pressing 105 min. 30 bar; 3rd step - hot pressing 15 min. 30 bar (temperature 160 C).

Figure 2. 3D Hot Forming samples (terrace floor, technical beam, I-beam and CLT board) (photo Ilkka Tarvainen)

The samples used in this project were spruce, pine and larch. Samples were soaked in water for three days before starting the actual hot pressing. The purpose of the high temperature and the variations of the pressure in the process was to get the moisture content as low as possible, without long drying times.

The topic of the next two workshops (Slovakia and Hungary) is to make laboratory tests on the samples produced in Finland. In the last workshop, students will concentrate more on productisation and marketing the products.

Second workshop in Zvolen, Slovakia

The aim of the second workshop in Zvolen Technical University in Slovakia, was to test the effects of 3D Hot Forming technology on the mechanical properties of different wood species, as well as to evaluate the pros and cons of applying the technology to industrial production. Three student groups worked with specified wood samples, which were chosen for the groups based on previous research and development work in the Lahti workshop.

In the second workshop, the target was to get to know the research methods for wooden terrace floorings. All three wood species (pine, spruce and larch) were tested in Zvolen University laboratories. The properties tested were surface roughness, hardness, abradability, glue joint adhesion strength and weather resistance.

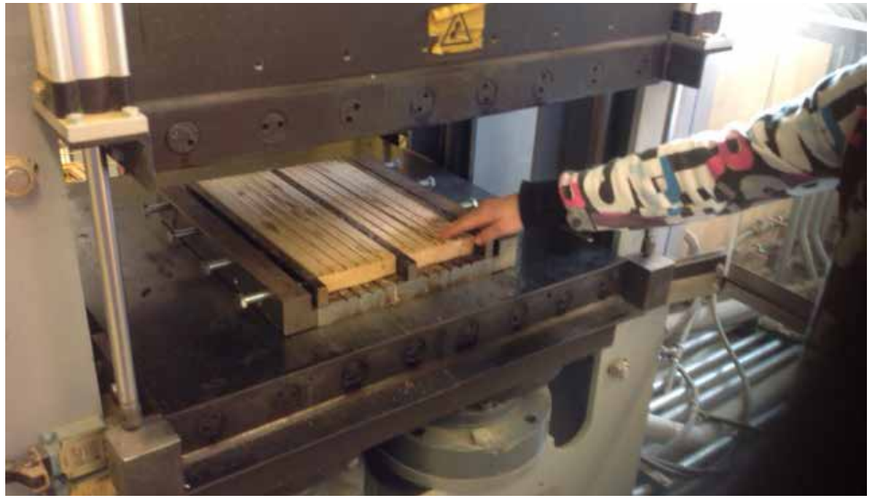


Figure 3. Terrace flooring boards in the 3D Hot Forming process (mould + wood + hot press) (photo Ilkka Tarvainen)

Figure 4. Students working in groups at Zvolen University (photo Ilkka Tarvainen)

The weather resistance testing was further divided into colour change, moisture content change and swelling properties. All the above-mentioned tests were performed on both untreated wood samples and samples that had been hot pressed and surface- treated.

In the second workshop all students learned new ways of testing wood. That was one target of the workshop. All the results were not as good as expected, but this is also part of the learning curve. There were also big differences in the results between different wood species.

References

Guoth, M. 2015.
Student report in a workshop

Kumpulainen, V. 2015.
Student report in a workshop
Motivational workshop, Application material.

Uusi teknologia sahatavaran jatkojalosteiden tuottamiseen. 2015 [referenced 1.11.2015].
Available at: http://www.ilvolankoski.fi

Reijo Heikkinen

Plastic Waste Gyres and Possible Methods to Clean Them

Oceans contain huge amounts of plastic waste that has ended up there due to human activities. Currents rotating in the oceans with enormous waste accumulations are called waste gyres or garbage patches. The gyres consist mainly of pieces of floating plastics which are lighter than water. These plastics are mostly polyethylene and polypropylene.

Plastic debris accumulates into the oceans in many ways. Plastics can be carried by surface waters and by wind from landfills. Plastics also end up in the sea from containers falling out of ships during storms. The number of missing containers is approximately 10 000 per year. Plastic waste is usually concentrated in ocean gyres, which can be 1000 km in diameter. For example, the North Pacific gyre has up to 960 000 plastic pieces in one square kilometre. The size of plastic particles ranges from microscopic to a few meters. Some 70 % of all waste that gets into the oceans is plastic and 41 % of that is packaging plastic. So-called micro plastics mainly originate from textiles and cosmetics. The cosmetics industry commonly uses spherical plastic particles between 1 and 1 000 microns.

Collecting plastic from the sea is difficult due to the huge areas. Foreign material should be collected by using passive filter-like structures that work independently for long periods without any demand for energy, maintenance or control. In this concept, a filter system made from recycled plastic is left to float in heavily affected areas. The filter collects non-living material when floating on the water, but lets living organisms pass through the filter. The filter is made up of crushed recycled plastic manufactured into elements, the surface properties of which have been modified in such a way that the floating plastic debris in the ocean remains attached to the filters due to the capillary effect and surface tension. There are ways to modify surface properties. For example, additives can alter the surface tension of polyethylene.

The plastics floating in the garbage gyres are mainly polyolefins. The characteristics of the filter can be developed so that floating polyolefins get attached to them. Most polymers that have different molecular structures are immiscible, but polyolefins, such as polyethylene and polypropylene, can be mixed together very well. This means that the entire filter can be processed into new products or burned for energy.

The size of plastic debris can range from microscopic particles to large pieces of a few meters. Plastic waste is divided into mega-

Figure 1. Plastic “soup” in a river in Amsterdam. It could be quite easy to prevent this from ending up in the sea and it would be even better if these items never end up in these rivers. People´s attitudes and education will make a difference in the future even in well developed countries (photo Plasticsoupfoundation.org)

debris (100 mm diameter), macro-debris (20 mm), meso-debris (5–20 mm) and micro-debris (0.5mm). When studying the size distribution of the particles, the main fraction is 1 mm in size. In Figure 1 is shown how plastic waste looks before it ends to the ocean. Roughly 80 % of the debris is between 0.5 mm and 5 mm. Plastic materials also undergo changes in size due to the effect of the sun’s ultraviolet radiation in the surface of water and near it.

Impacts of Plastic Waste

Plastic pieces themselves are very dangerous to living organisms. They may get stuck in the parenteral canal of animals and also cause problems by entangling around the animals. Furthermore, ocean debris can be highly toxic, since plastics tend to absorb environmental pollutants. Plastics can accumulate up to 1 000 times the amount of toxic substances from the sea, compared to what they originally contained. This is a serious problem, as microplastics are commonly consumed by small organisms. These organisms are at the bottom of the food chain. This means that when bigger animals eat these organisms, toxins concentrate more at each step in the food chain. These fundamental issues have been raised by Galgani. Toxicity of ocean plastics can be a restricting factor for the reuse of materials. If the toxin level is too high, the only option for reuse can be to use ocean plastics for energy.

Plastic debris has a long lifespan in surface water, so the amount of plastic in the ocean will continue to increase. The use of plastics in certain applications will probably be limited in the future, but with the current technology, all plastics cannot be replaced by any other material. Some items are difficult to replace by other materials, though these plastics could be replaced by a biodegradable option. Plastics have not always been utilized well and there have been poor designing, but in many cases it is the use of plastics that allows us to have the current standard of living and technology (fig 2).

TOP TEN MARINE DEBRIS ITEMS

RANK	DEBRIS ITEM	NUMBER OF DEBRIS ITEMS	PERCENTAGE OF TOTAL DEBRIS ITEMS
1	CIGARETTES/CIGARETTE FILTERS	2,189,252	21%
2	BAGS (PLASTIC)	1,126,774	11%
3	FOOD WRAPPERS/CONTAINERS	943,233	9%
4	CAPS, LIDS	912,246	9%
5	BEVERAGE BOTTLES (PLASTIC)	883,737	9%
6	CUPS, PLATES, FORKS, KNIVES, SPOONS	512,517	5%
7	BEVERAGE BOTTLES (GLASS)	459,531	4%
8	BEVERAGE CANS	457,631	4%
9	STRAWS, STIRRERS	412,940	4%
10	BAGS (PAPER)	331,476	3%
	TOP TEN TOTAL DEBRIS ITEMS	8,229,337	80%
	TOTAL DEBRIS ITEMS WORLDWIDE	10,239,538	100%

SOURCE: OCEAN CONSERVANCY/INTERNATIONAL COASTAL CLEANUP 2019

Figure 2. Typical items in the plastic debris. Note that this is just the number of single items, not tonnage. Some of these items are difficult to replace by other materials. Though these plastics could be replaced by biodegradable option. (The Ocean Conservancy, 2015)

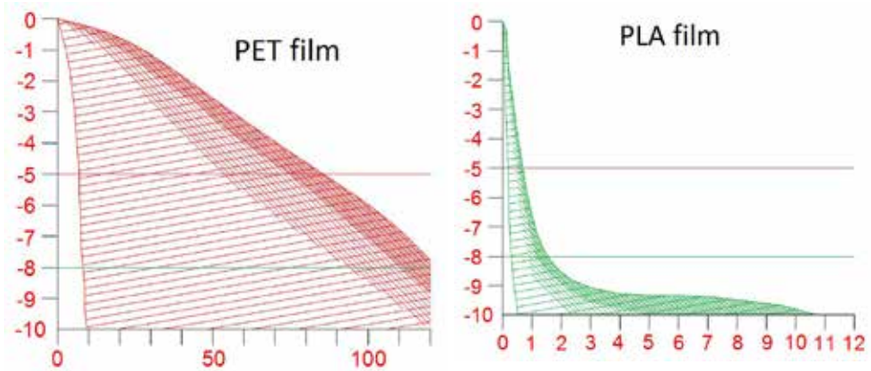


Figure 3. Degradation of polyester and polylactide commonly used in plastic packaging. The dimension scale on the vertical axis is logarithmic and numbers refer to exponents with base 10. The 0 resembles 1 m. The horizontal axis refers to years. The upper horizontal red line refers to the limit of visibility and the lower green line refers to the limit of atomic scale when the polymer is considered to be completely degraded to small and relatively harmless molecules.

In addition to collecting garbage, people should be more focused on preventing the plastic debris from drifting out of control to nature. In a few countries, such as Switzerland, recycling of plastics is highly advanced, and nearly 100% of discarded plastics are recovered for recycling. This means that it will also be possible in other countries. In Finland, only a third of all plastics is recovered, which means that two thirds of plastic waste disappears. It is possible that this part ends up in nature or oceans. Many bigger countries have even lower rates for recovering and recycling plastic waste. Biodegradable plastic is one answer to this problem. As can be seen in Figure 3, there is a significant difference in the speed of degradation of biodegradable and non-biodegradable plastic.

Technologies for Collecting Plastics from the Oceans

There have been many research projects studying marine pollution near Finland, mainly in the North Atlantic Ocean and the Baltic Sea. These projects have focused mostly on the effects of waste on fisheries and marine life. The projects have produced valuable data on plastic debris for developing systems of collecting plastic material from the oceans.

There are some methods and systems for collecting plastics from the oceans. Usually these are barriers like dams, as seen in Figure 4, which concentrate plastics for easier collection and filtration.

Plastic dust collection is possible with a passive disposable collector, which can be either burned for energy or processed to products after use. Collection of plastic materials should not be dependent on weather conditions because the collector must float on the sea for a fixed period of time. The structure of the filter, which collects smaller plastic particles, is important. Very few existing collectors have the ability to collect debris from some decametre wide port at one time. Debris would not stick to these collectors, since they are only some kind of passive fences, which concentrate debris to make it easier to gather.

There is another way to collect marine debris by using porous structures made from recycled plastics. This idea is under development at Lahti University of Applied Sciences. Collectors work better if they have active surfaces or some other structure which aggregates certain particles into the structure of the collector. The collector's ability to collect plastic is based on

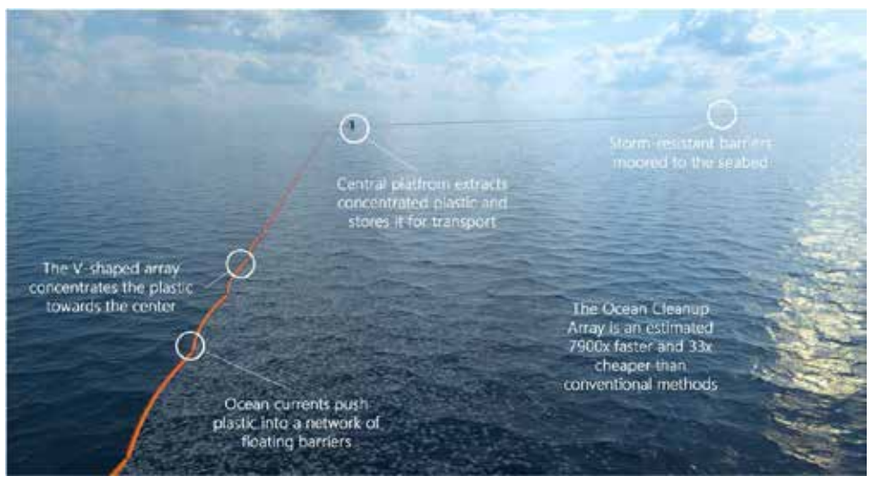


Figure 4. One possible method to collect the debris from the ocean. The floating barriers concentrate trashes for picking. (The Oceancleanup, 2014)

the phenomenon that certain types of plastics have a hydrophilic surface. The plastic surfaces of the filter must be treated in such a way that they become easily watered. It can be assumed that plastic particles that have been in the ocean for a long time are affected by the sun's ultraviolet radiation, which changes the surface properties of the plastic when it floats on the water. New plastic items do not have this kind of properties and must be collected by other methods.

When the filters have been in the ocean for a certain period of time, they are lifted for processing. Processing can be done either for energy production or for making new products from the filter. Possible toxic chemicals should be taken into account in the reuse, and also if burning the plastics (Figure 5). Prior to the use of the filter, it is important to take samples for research purposes. Filters can also be used as collectors of plastic debris for researchers. One advantage will be the possibility to study the durability of materials in marine conditions.

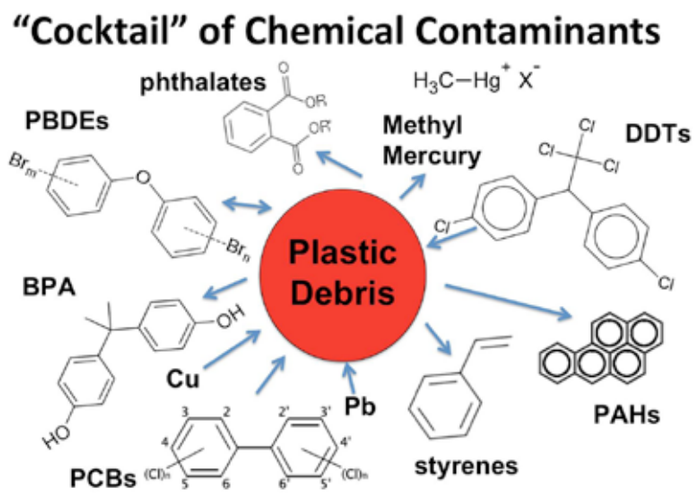


Figure 5. Plastic can absorb and release numerous harmful and dangerous chemicals. When animals eat plastic there is a huge risk of bioconcentration of the toxins in the food chain. (Deepsea News, 2015)

Used filters must be tested prior to processing to verify the suitability of the filter material for processing new products by various methods, such as injection moulding and extrusion. The products and properties of the material can be tested for the mechanical and chemical properties, and appearance. It has been found that the same types of plastics mix well with each other in melt processing. Mixed plastics have characteristics that are the average of various components of a certain mixing ratio. When the chemical properties of the polymer molecules and the structures are similar, mixing is complete. Similar structures can also be directly polymerized monomers. For example, polypropylene and polyethylene mix together perfectly without separating two different phases.

The filter operation is based largely on the surface tension and the resulting capillary effect. A study by Paunov focuses in particular on the plastic surface phenomena in liquid environments, where the plastics very often occur in nature. The modification of surface properties is very important so as to reach perfectly operating systems. The surface characteristics of the filter are very important for the macroscopic structure in order for the filter to collect debris of various sizes as efficiently as possible. The study of surface properties is particularly important when developing a filter structure that effectively collects polyolefins. Testing the operation of the filter can be done by using a prototype, which will be tested both in laboratory conditions and in the field. Also, the effects of sea water must be considered due to the increasing acidification of the seas.

There are two main ways to reuse filter material. The first is recycling filters for energy. For example Kymijärvi II, the waste-to-energy combined heat and power plant of Lahti Energy, uses 16.7 % of recycled waste for energy production. Another way of reusing the filters is to make new products from the material. However, there is a high risk of the materials being toxic, since plastics tend to accumulate certain pollutants. For example polypropylene absorbs especially PAH and PCB compounds and becomes harmful, even though these substances disintegrate when incinerated.

It seems that there are not so many ways to collect plastic waste from the oceans, due to the vast areas to be handled. Still, it will be more and more important to eliminate the effects of plastic waste on nature. The use of truly biodegradable plastics is one way. Another way is to develop proper recycling methods but there may be problems related to legislation and good will before perfect recycling becomes possible. The change in attitudes could take generations.

References

Andrady, A. & Neal, M. 2009.
Applications and societal benefits of plastics. Philosophical Transactions of the Royal Society. B.

Barnes, D., Galgani, F., Barlaz, M. & Thompson, R. 2009.
Accumulation and fragmentation of plastic debris in global environments. Philosophical Transactions of the Royal Society. B.

Brown, H., Char, K., Deline V. & Green, P. 1993.
Effects of a diblock copolymer on adhesion between immiscible polymers. 1. Polystyrene (PS)-PMMA copolymer between PS and PMMA. Macromolecules, 1993, 26 (16), pp 4155–4163

Cozar, A. & Echevarria, F. 2014.
Plastic debris in the open oceans. PNAS Direct Submission.

Deepsea News. 2015. [referenced 23.10.2015]
Available at: http://www.deepseanews.com/2013/12/guest-post-the-invisible-consequences-of-mistaking-plastic-for-dinner/

Galgani, F., Hanke, G., Werner, S. & De Vrees, L. 2013.
Marine litter within the European Marine Strategy Framework Directive., ICES Journal of Marine Science.

Galgani, F., Gerdts, G. & Hanke, G. 2011.
Article in Marine Pollution Bulletin. 62. p. 1589 – 1591.

Gregory, M. 2009.
Environmental implications of plastic debris in marine settings --entanglement, ingestion, smothering, hangers-on, hitch-hiking and alien invasions. Phil. Trans. R. Soc. B.

Hopewell, J., Dvorak, R. & Kosior, E. 2009.
Plastics recycling: challenges and opportunities. Phil. Trans. R. Soc. B.

Howe van den, S. 2006.
Science-policy interface for the deep sea: The case of the HERMES project. Marine Conservation in Europe 2006. Proceedeings of the symbosium, p.241.

Kralchevsky P. A., Paunov, V. N. & Nakayama, K., 1995.
Lateral capillary interaction between particles protruding from a spherical liquid layer. Journal of Fluid Mechanics, Vol 299. pp. 105-132.

Laffoley, D., Hawkins, S. & Turley, C. 2006.
Climate change, surface ocean acidification and their impacts on European seas. Marine Conservation in Europe 2006. Proceedings of the symbosium, p.133.

Lahti Energia Oy. 2014. [referenced 12.11.2014].
Available at: http://www.lahtienergia.fi/lahti-energia/energian-tuotanto/

Lipovetskaya, Y. 2010.
Solid Polyethylene Microspheres for Effects in Color Cosmetics, Cosmetics and Toiletries.

Luettmer-Strathmann J. & Lipson J. E. G. 1998.
Miscibility of Polyolefin Blends. Macromolecules 1999, 32, 1093-110. Department of Chemistry, Dartmouth College, Hanover, New Hampshire.

Mastrangeli, M., Arutinov, G., Smits, C. & Lambert, P., Modeling capillary forces for large displacements. Department of Bio, Electro and Mechanical Systems (BEAMS), Ecole Polytechnique de Bruxelles

Moore, C. 2008.
Synthetic polymers in the marine environment: A rapidly increasing, long-term threat, Environmental Research, 108(2), pp. 131–139.

Moore C., Moore S., Leecaster M. & Weisberg M. 2001.
A Comparison of Plastic and Plankton in the North Pacific Central Gyre. Marine Pollution Bulletin 42. pp. 1297-1300.

The Oceancleanup. 2014. [referenced 11.11.2014].
Available at: http://www.theoceancleanup.com/

The Ocean Conservancy. 2015. [referenced 9.9.2015].
Available at: http://www.oceanconservancy.org/our-work/international-coastal-cleanup/top-10-items-found-1.html

Paunov V., Kralchevsky P., Denkov N., Ivanov L. & Nagayama K. 1992.
Capillary meniscus interaction between a microparticle and a wall, Colloids and Surfaces, 67 (1991) 119- 138, Elsevier Science Publishers B.V. Amsterdam.

Plastic Soup Foundation. 2015. [referenced 22.9.2015].
Available at: http://www.plasticsoupfoundation.org/2014/04/amsterdam-opent-jacht-op-plastic-soep/

Rochman, C., et al. 2013.
Long-Term Field Measurement of Sorption of Organic Contaminants to Five Types of Plastic Pellets: Implications for Plastic Marine Debris. Environmental Science & Technology.

Ryan, P., Moore, C., van Franeker, J. & Moloney,C. 2009.
Monitoring the abundance of plastic debris in the marine environment. Phil. Trans. R. Soc. B 364, 1999–2012.

Song, J., Murphy, R., Narayan, R. & Davies, G. 2009.
Biodegradable and compostable alternatives to conventional plastics. Phil. Trans. R. Soc. B.

Teuten, E., Saquing, J., Knappe, R. & Morton A. 2009.
Transport and release of chemicals from plastics to the environment and to wildlife. Phil. Trans. R. Soc. B.

Thompson, R., Moore, C., Andrady, A. Gregory, M., Takada, H. & Weisberg, S. 2005.
New directions in plastic debris. Science. 310. p. 1117.

Thompson, R., Moore, C., von Saal, F. & Swan, S. 2009.
Plastics, the environment and human health: current consensus and future trends. Phil. Trans. R. Soc. B 364, 2153–2166.

Thompson, R., Swan, S., Moore, C. & vom Saal, F. 2009.
Our plastic age. Phil. Trans. R. Soc. B 364.

Thompson, R., Park, C. & Chen, P. 2010.
Reduction of Polymer Surface Tension by Crystallized Polymer Nanoparticles. The Journal of Chemical Physics, 133.

Thompson, R. 2006.
Plastic debris in the marine environment: Consequences and solutions. Marine Conservation in Europe 2006. Proceedeings of the symbosium, p.107.

Webecoist. 2014. [referenced 11.11.2014].
Available at: http://webecoist.momtastic.com/2011/04/19/deep-cargo-an-ocean-of-lost-shipping-containers/

Westergaard, O., Sorensen, T. & Hoffman, E. 2006.
Marine protected areas as a tool for ecosystem conservation and fisheries management – overview and initial findings of the research project PROTECT. Marine Conservation in Europe 2006. Proceedings of the symbosium, p.247.

Saara Vauramo and Eira Rosberg-Airaksinen

Energy Efficiency and Systems Change Won't Happen by Itself: City of Lahti Makes Concrete Actions for Sustainable Built Environment

It is not enough that we all change to green electricity or electric cars. The decoupling of greenhouse gas emissions and economic growth needs almost miracles to happen: the use of fossil fuels has to be dropped to a minimum, energy efficiency of buildings and industries has to be improved massively and the revolution in traffic sector must be fully exploited, leading to a society that walks and uses bicycles and the public transportation many times more than today. Do we have enough courage and will to make this happen?

The City of Lahti has shown political willingness to change the course and take its responsibility for climate change mitigation. The city strategy of Lahti manifests a 50 % decrease in greenhouse gas emissions in its area from the 1990 level by 2025. In practice, there is a large array of on-going climate actions from renewable energy investments to large-scale energy efficiency improvement and renovation of the public transportation system. The updated list of these actions can be found in the Sustainable Energy Action Plan of Lahti (2013-2020). The climate change mitigation efforts of Lahti City were recognized by WWF in the Earth Hour City Challenge 2015 competition, were Lahti was nominated the Finnish capital of the year.

Figure 1. The CO^2 emissions of Lahti decreased 17 % from the 1990 level by 2013. The aim is to cut 35 % of emissions by 2020 and 50 % by 2025 (Sustainable Energy Action Plan of Lahti 2013-2020)

Energy-saving investments with ESCO project

The energy efficiency of the built environment provides a very fruitful arena for cutting the CO^2 emissions as there is also high potential for profitable investments. The City of Lahti launched a tendering of the ESCO (Energy service company) project in 2012-2013 as a part of Green City program. The ESCO project includes 10 major city-owned buildings, some of them being landmarks of Lahti: Lahti City Hall, the winter sports arena and the Sibelius Hall (Fig 2). The idea of the ESCO project is to build a partnership with a company that provides energy efficiency solutions. The investments to energy efficiency are paid back with savings from lower energy consumption of buildings. Siemens won the tendering of the ESCO project. The city of Lahti and Siemens have now a 10-year contract and an agreement of 30 % energy savings of the buildings. This year (2015) and the spring of 2016 will be the construction phase of the project.

Not everything has been easy with the ESCO project. The 103-year-old City Hall of Lahti is a historic building, which makes any changes to its architecture unwanted. It has been a complicated process to fit the new energy equipment to this old and valuable building. The winter sports arena of Lahti was yet another problematic case. During the planning phase of the ESCO project, Siemens got an idea of installing a large solar energy system on top of the building. However, it soon became clear that there was an acute need to improve the concrete structures of the main stand. With this large renovation, it was also possible to fit solar panels of energy production potential of 120 kW. There was a thorough discussion again with the architects about the changing appearance of the building. Finally, there was a compromise where the architecture and solar energy could be fitted together.

Figure 2. Major landmarks of Lahti City: the winter sports arena, Lahti City Hall and Sibelius Hall are included in the ESCO energy efficiency project 2012-2022. (City of Lahti)

What does energy efficiency mean for the city?

All in all, energy efficiency is a big financial issue. Lahti Group companies and Lahti Premises together used ~240 000 MWh of energy for heating and electricity in their buildings in 2014. However, the efficiency of public buildings in the City of Lahti has improved significantly during the past 5 years. It has been estimated that the improved energy efficiency saves several hundred thousand euros of tax payers´ money every year.

Although existing buildings form the biggest energy-consumption mass, it is also important to take a closer look at new public buildings. During this year, the construction of two new schools, Jalkaranta and Liipola, was finished. These schools, designed as multifunctional public buildings, score high on energy-efficiency. The new multi-use schools are built to be low-energy houses. The real-life energy consumption figures will be reliable only after first year of use. At the moment the low-energy requirement level for public building is 170 kWh/netto m2, which is -30% less than for so called normal public building. After 2018 all new public buildings should be near-zero-level. The actual requirement number is not yet published, but it might be something like 140-150 kwh/m2, and these numbers include the use of warm water too.

The City of Lahti has made an agreement with the Ministry of Economics and Employment on continuous energy efficiency improvement. The energy efficiency agreement aims at 8 % energy savings in city-owned buildings from the 2005 energy use level by 2016. The energy efficiency agreement is a voluntary model

Figure 3. Energy consumption rate (kWh/m3) of municipality owned buildings in Lahti. The improvement in energy efficiency during the previous years follows a trend line of 15 % energy saving from the 2005 level until 2016.

through which the government encourages municipalities to take further steps to cut the energy use of buildings. The process is currently under evaluation and is likely to be renewed: new targets for the next few years are being considered. As the “low-hanging fruits” of energy efficiency have soon been picked, it will become significantly more difficult to achieve the new targets and get even more energy saved.

Guidance for builders and residents

The pressure to consider the energy efficiency when starting a building project has increased dramatically with the new construction regulation of Finland since summer 2012. Residents show ever increasing interest in energy issues, but often find inadequate information or even subjective advice. The City of Lahti is currently building a web-based energy choice service “Energiavalinta.fi”, which will enable property-owners and citizens to compare different energy solutions, like solar energy, geothermal or pellet heating or green electricity. The new service will be ready by summer 2016. It is highly important that citizens will be able to get objective information about the most potential energy solutions, when the energy renovation of an older building is at hand, or when planning a new building and its long-lasting energy choices. Will all this development then finally lead into a low-carbon society with new blooming energy businesses and climate-conscious citizens? We cannot be sure, but it definitely looks like the City of Lahti has stepped onto that path.

Figure 4. Solar panels on top of the Onnelanpolku eldery care home (photo Lauri Rotko)

Conclusions

The City of Lahti has seen environmental issues important key areas in its strategy. Also, remarkable investments and international and national agreements have been made to proceed with climate mitigation. Cleantech companies are important in the Lahti region and not only because their turnover is growing more than with the rest of the companies. However, reducing emissions is getting harder, when “easy actions” have been taken. Also, results of actions cannot be seen immediately but after some years. There is a limit to how much the City of Lahti can with its own actions affect the greenhouse gas emissions of the whole city area, especially through urban planning and development of a more energy efficient built environment and traffic solutions. In order to achieve the dream of a sustainable built environment, actions from other parties of society – people and businesses - are also very much needed.

References

Arola, Jouni. 2015.
Building Manager. Lahden Tilakeskus. Interview 16.10.2015.

Motiva. 2015.
Millainen on energiatehokas pientalo [referenced 2.11.2015]. Available at: http://www.motiva.fi/rakentaminen/millainen_on_energiatehokas_pientalo/matalaenergiatalon_maaritelmia

Sustainable Energy Action Plan of Lahti 2013-2020 [referenced 2.11.2015].
Available at: http://www.lahti.fi/www/images.nsf/files/7B22B99E7D2C58B7C2257E5B003A0806/$file/Lahti_SEAP_131202.pdf

Ympäristöministeriö. 2015.
Suomen rakentamismääräyskokoelma [referenced 2.11.2015]. Available at: http://www.ym.fi/fi-fi/maankaytto_ja_rakentaminen/lainsaadanto_ja_ohjeet/rakentamismaarayskokoelma

Paul Carroll

Energy Saving Counselling through Student Participation

The modern consumer faces the challenge of reducing the amount of energy used, while not compromising the comforts and convenience of modern life. It is now routine to consider such urban planning issues as the sense of security and modernity provided by well-planned lighting in a residential area or a shopping precinct. The promotion of energy efficiency and the marketing of low energy products represent business opportunities that have arisen from obligations to reduce emissions and otherwise carry out sustainable practises. Stephenson et al. attempt to establish a framework to help to understand factors that influence energy consumption behaviour, looking into cultural factors among other things. Their objective is to identify opportunities to change how people act.

In Finland there are many good examples of systematic methods of improving energy efficiency in enterprises, such as the ESCO (Energy Saving Company) concept. These predominantly involve a consulting company. Since this aspect of Cleantech has been identified as a promising employment source for environmental engineering graduates, optimal approaches were sought to supply information to different stakeholder groups through a suitably targeted practically oriented section of their curriculum. In practise, this has been carried out as part of a broader course on consumer energy efficiency counselling.

Figure 1. Environmental counselling at Ympäristökylä event (photo Terhi Kuisma)

The course

Starting in 2012, there has been a national programme eneuvonta (e-counselling), which has been promoted and also partially funded by the affiliated government agency Motiva Ltd, an expert company promoting efficient and sustainable use of energy and materials. Local projects implementing this programme were organised by regional organisations. Lahti Region Environmental Services (abbreviated in future as LSYP, from the Finnish name) coordinated this activity and attracted several municipalities in the region as well as the energy producers and distributor companies Lahti Energy and Kymenlaakson Sähkö (Kymenlaakso Electricity). The only educational organisation involved as a paying partner was Lahti University of Applied Sciences (Lahti UAS).

Through involvement in this annual project Lahti UAS has been able to give a practical course entitled Energy Counselling and implemented in cooperation with LSYP. The course is based on the skills and knowledge required to plan and implement counselling in the efficient use of energy and the choices involved in consumption. The course, which was organised for the third time in autumn 2015, consists of several elements that the students need to be involved in to be assessed and graded. It differs from regular classroom activity in that there is very little in terms of theoretical lectures. Instead, students are encouraged to gather and present their own material in a form suitable for particular kinds of recipients.

The four central activity requirements of the study course are:

1. Attending an energy counselling session of their own choice, organised by LSYP
2. Participating in the planning and implementation of an exhibition held during the Energy Saving Week
3. Producing a short energy counselling presentation aimed at a specific listener group
4. Attending a specially organised heat pump maintenance course, with the view of being able to give this same advice themselves.

In 2015, funding for the national e-counselling programme was reduced compared to the previous years, in that instead of directly funding the municipalities in their activities Motiva only provided marketing material and coordinated activities such as the national Energy Saving Week. Also, the number of municipalities in the Lahti Region involved in the programme this year was less than before, due to cutbacks in their budgets. Nevertheless, the involvement of Lahti UAS was not affected by these and the course proceeded as before. The aim was to learn from the experiences of the previous years, while continuing to address the same issues of reflecting upon the kind of information and advice people need on energy saving, and in which way and at what events and locations it should be offered for maximal impact.

This course also represented a challenge for the lecturer in that it was important to stick to the central objective of providing the students with the skills needed to become “energy counsellors” themselves. This implies more than simply knowing about energy-saving issues and being able to answer questions. It also means anticipating the kind of advice the public might need and reflecting on the best means of providing it. The writer and lecturer in this course predominantly took the approach of letting the Lahti UAS students make their own observations from real energy counselling events organised by LSYP and reporting on them afterwards.

Course activities

In order to fulfil the first course task, the events and environmental services attended by the students were as follows:

- a stand at the annual fish market in the harbour,
- a “pop-up” info stand located in the city library,
- an evening event for those interested in ground source heat pumps,
- an info point on the monthly city market day at the Lahti Market Square

A couple of other events were offered but did not have student participants. The instructions given by the lecturer were that the students had to participate as actively as possible while also making observations as to the success of the event, the location and the merits and demerits of the approach used. The intention was to allow them to really have an influence during the course or in the future on implementing effective energy counselling activities. The teachers in the environmental engineering programme are often asked about the types of jobs graduates could possibly be involved in later, and that is why it was explained early on in the present course by the writer that a number of those participating could find themselves in working life either in a municipal environmental office responsible for this kind of public targeted activity, or alternatively working for a consulting company in some similar aspect of promoting cleantech.

As the second task listed for this course, the students set up an exhibition for the duration of the annual Energy Saving Week. The location was in the central hallway area of Lahti Science Park, where the environmental department of Lahti UAS Faculty of Technology is located. It is a challenging location as people mostly just pass through on the way to and from work or study. By sharing roles and thinking up elements of the exhibition, the participating students were able to choose what they most preferred to do: two students managed the marketing, two more created a quiz in energy efficiency with prizes supplied by a power company, others made counselling videos, and one brought his own

Figure 2. The logo of the e-counselling project concept.

Figure 3. Energy Saving Week exhibition (photo Paula Pitkänsalo)

electric bicycle. Together they set up the stands with "hands-on" demonstration elements of their own and from Lahti UAS, as well as the LSYP energy efficiency toolkit of appliances and a lamp display for comparison to help in consumer choices. Mostly the stand was not manned over the 5-day period, but passers-by were free to take brochures, participate and admire the stands. Difficult as it is to assess the success of such an event, the planning and construction of it provided a learning experience and all the varied users of the Science Park and students and staff of Lahti University of Applied Sciences were aware of the exhibition and that energy efficiency was being promoted that week.

Figure 4. The dedicated logo for Finnish Energy Saving Week.

The third integral project activity, which students had to carry out, was either individually or in pairs to prepare a brief "freestyle" presentation on some specific aspect of energy saving for consumers. It was intended to be brief but focused, rather than all-encompassing and too general.

The following themes were chosen:

- Winter-related energy saving issues, e.g. pre-heating options for cars
- Choice of sauna type
- Desktop or laptop computer
- Types of lighting in homes/street light options
- Choosing a washing machine/energy saving in washing clothes
- Energy saving through food choices
- Warm water and energy
- Balcony glass benefits
- Home heating and insulation

A common factor is that all these refer to consumer counselling, particularly targeting householders. While it would have been an interesting learning task to also create such presentations for enterprises, none of the students chose that option, presumably for reasons of perceived difficulty dealing with the specific activities involved in different fields of activity.

Heat pump course

The final course section was a specially organised heat pump maintenance course. The aim was to give the students a practical skill that consumers frequently require. Apprehension about not being able to maintain their own air-air heat pumps is one reason why consumers do not purchase them, even though it is almost without exception a wise decision to install one in the home. A professional from a private company specialising in heat pumps came to the laboratory area of Lahti UAS and went through the different steps involved. It is a surprisingly easy operation and the students followed it while keeping in mind that they should be able to explain the process through clear language and demonstration and thereby help to "demystify" in the eyes of normal consumers the challenges attached to owning an air-air heat pump. This part of the energy counselling course was arranged via LSYP as part of the joint project cooperation and represented a concrete skill learned by the students in addition to the various conceptual skills of anticipating consumer needs and reacting to them with suitably planned and targeted information offerings.

Feedback in reports

It was very interesting to read the students' observations and remarks about the public energy information events. To mention a couple of them (in free translation of the author), a male student remarked: "It was surprising to notice the people really wanted to ask information about energy matters. I myself would just do an internet search for it. This is probably a question of the behaviour of different age-groups." A female student pointed out: "I don't like when someone hunts after people and

makes them take brochures, but when they are interested and attracted enough to come to the stand of their own accord it is then more worthwhile and useful." These kinds of remarks attest to the kind of learning process involved and demonstrate the effectiveness of obliging students to participate, reflect and come to their own conclusions.

Final remarks

Sweeney et al. present a list of barriers to energy saving behaviours, based on their research results (carried out in Western Australia but equally applicable here). They sub-divide the results into curtailment behaviours, which save energy through reducing use, efficiency behaviours, which save energy by buying more efficient appliances, and maintenance behaviours, which save by improving how appliances are maintained to make them less wasteful. Being aware of behavioural patterns is one large step towards improving them, but the challenge remains of how to make consumers, enterprises and municipal decision-makers aware of how they can implement many of these behavioural patterns with the least amount of pain or disruption to their present activities or lifestyles. Initiatives such as the energy counselling activities outlined here are worthwhile, but offer no instant remedy in the short term. The increased knowledge obtained from this year's experiences, when acted on by the environmental services (LSYP) and further developed in follow-up courses, will allow next year's activities to increase their impact.

References

Motiva. 2015.
Specialist in Material and Energy Efficiency [referenced 25 October 2015]. Available at: http://www.motiva.fi/en

Stephenson, J., Barton, B., Carrington, J., Gnoth, D., Lawson, R. & Thorsnes, P. 2010.
Energy cultures: a framework for understanding energy behaviours. Energy Policy 38, 6120-6129.

Sweeney, J.C., Kresling, J., Webb, D., Soutar, G.N. & Mazzarol, T. 2013.
Energy saving behaviours: Development of a practice-based model. Energy Policy 61, 371–381.

Eeva Aarrevaara

Energy Efficient Urban Planning

The Finnish government updated the National Climate and Energy Strategy in 2013. The strategy set new targets for 2020 and also started to prepare for a carbon neutral society in 2050 according to the long-term energy and climate objectives set by the EU. According to the strategy, energy production based on renewable energy sources should be integrated into buildings and energy systems. EU targets for 2020 for the reduction of greenhouse gas emissions, share of renewable energy sources in final energy consumption and improving energy efficiency are all within the level of 20 %, which Finland is committed to follow. Still, the needed reduction of carbon emissions might be nearer to 30 %, if the aim is to limit global warming to two degrees Celsius.

In urban planning the main concerns for energy efficiency are the urban structure, buildings and transportation, which affect the carbon emissions. The density of urban areas has been discussed a lot and a common belief has been that the higher the urban density is the better the energy efficiency of the area. Still, in urban planning different factors should be in balance to achieve the best solutions to provide attractive and healthy living environments for all.

An integrated and energy efficient community has certain benefits. Town building is compact, aerial and site density relatively high and there will be less need to travel for local services. Densely built areas can provide socially and culturally lively environments. This kind of area is able to provide good opportunities for walking and cycling and also for extensive public transport. Residents can be thus encouraged to go to work by other means than private car. In new areas the adaptation of energy efficiency is easier than in already built environments although in every environment there are possible improvements concerning energy efficiency.

Built environment, location of the buildings and land use in general

According to the ERA17 report, the emissions of buildings and constructions are about 40 % and the amount is even higher when emissions from transport are included. In urban planning not only the quality of the buildings is considered but also the location of the buildings in the area. When possible, one should consider the topography, microclimate and orientation of the groups of buildings. The buildings could form sheltered yards and benefit from passive solar energy from south and west. Well-considered orientation of buildings can benefit regional energy efficiency and also create an agreeable microclimate with sunshine to the immediate surroundings. Winds and shades should also be examined in the new areas to avoid negative effects on the built environment. Skilful use of vegetation will also create more protection to living environments. The density of the built area is only one aspect which must be considered together with other needs for different land uses in neighbourhoods or city centres.

Public transport, pedestrian and cycling routes

In new areas the planning of convenient routes for pedestrians and cycling is an essential factor to support the internal traffic. Safe routes without many crossings with heavier traffic are recommended. A practical solution in the area can be based on an inner network while car traffic is rotating outside the area. The bus stops should be situated at a walking distance from

Figure 1. Model of Niemi area in Lahti built by Lahti UAS students (photo Maarit Virtanen)

most built areas to encourage the use of public transport. The safety of the traffic environments is very essential, especially for children, elderly and disabled people.

Green areas

A network of green areas is considered an important factor in planning processes today. Green areas are able to provide different ecosystem services to the built areas. Their impact is also meaningful for the local climate because vegetation has a cooling effect. Green areas work as natural places to gather and delay stormwater, which sometimes causes flooding in town areas. Connected with well-planned and well-designed pedestrian and bicycle routes they provide services for recreation and aesthetics to the residents. The green environment should also contain larger areas to maintain natural processes in ecosystems. Several cities are interested to pay more attention to so called quality channels for bicycles. One example of this was the Bachelor's thesis by Ninni Heinonen, where she made a report concerning quality routes for cycling in the city of Porvoo.

Waste management

The separation and transportation of waste from residential areas have immediate impacts on the living environment. Waste separation must be arranged in the surroundings of buildings. Waster separation is developing continuously and new opportunities are available either in the residential area or in separate waste collection points. New technologies are an alternative in new settlements. For example, pipeline-based waste collection systems have already been installed in some areas in Tampere and Helsinki. In her Master's thesis, Inna Harju examined the experiences from pipeline-based waste collection systems in Kalasatama and Jätkäsaari in Helsinki. In a pipeline-based collection system, the waste is transferred by big pipes to containers, from which they are transported to waste treatment areas. Thus the traffic in the residential areas can be diminished. Based on the research, she made the conclusion that the system works well but the users still need more instructions and guidance to separate their waste in a better way.

Heating methods

Municipalities have under certain conditions the right to determine the heating method in the land use plans. This opportunity is seldom utilized but must also be considered in planning. It has been noticed that district heating is the only network business in which the prices are not controlled by a certain act. District heating has been discovered to be the most energy efficient way of heating in densely built neighbourhoods, especially when a significant part of the heat is produced by renewable energy. Also solar panels can be used to add to the amount of renewable sources.

Figure 2. Urban cycling

Figure 3. Solar panels (photo Jussi Kuusela)

Skaftkärr – an example of energy efficient town planning

The city of Porvoo and The Finnish Innovation Fund Sitra started a development project in 2008 dealing with a new urban area Skaftkärr, situated south of the city centre. The main aim of the project was to develop methods for energy efficiency in urban planning. In the planning the following viewpoints have been taken into account: community structure, aerial energy consumption, energy production in the area, traffic and its environmental impacts, services and the social environment, way of building and new energy solutions, and new action models. In the detail plan of Toukovuori, the area where the development started, separate tools and reports were made concerning energy efficiency. The climate impact of energy consumption caused by the buildings, the carbon footprint of the constructions and the impact assessment of the municipal engineering were gathered in one report.

Energy efficiency is visible in the cityscape of Skaftkärr in many ways, such as the materials, shapes and orientation of buildings. In town planning, new elements like bus street and bicycle expressway were taken into use as a conclusion of energy efficiency requirements. For the same reason, the building density was defined relatively high. Connection to district heating was also determined in the town plan. The authorities responsible for the implementation of the plan also participated in the planning process; these included representatives of building inspection, the water company, the energy company, community development and land surveying. This proved to be a very useful decision because thus the implementation could be anticipated already in the planning phase. It was noticed that in the planning process there was a need for different easy-to-use tools for measuring the energy efficiency.

Eco-efficiency in the Hakametsä area in Tampere

Ida Montell wrote her Bachelor's thesis about energy efficient planning of the Hakametsä area, which is situated in a central area in the city of Tampere. The thesis was finished in 2015. The aim of her work was to carry out an eco-efficiency analysis of the general plan of the Hakametsä area.

The investigation of the suitability of the eco-efficiency tools for the general plan was one goal in the thesis. Another target was to seek for development ideas to improve the eco-efficiency connected with the general planning process. In a project called EHYT the city seeks for suitable areas to densify the city structure. Thus the climate change effects are taken into consideration in city planning. In the thesis, one way of examining the methods to measure eco-efficiency was by applying three different tools in Hakametsä: the HEKO tool, which has been used to measure eco-efficiency in planning in Helsinki, the emissions measurement tool for detail planning, and the carbon balance measuring tool. Only HEKO concentrates on total eco-efficiency and includes different criteria for energy consumption, waste amounts and ecosystem impacts, which get a weighted value according to their importance for the total efficiency. As a conclusion, the author notes that measuring eco-efficiency is very challenging and requires systems which are transparent, so that the used criteria can be evaluated. It is also difficult to decide what values to give to different impact factors. Still, the measuring results can be useful in planning but the interpretation must be carried out carefully.

Nowadays there are a large number of different tools and systems to evaluate eco-efficiency. If they are selected and used critically, the measurement tools may be helpful when making planning decisions.

References

City of Porvoo. Skaftkärr [referenced 9.11.2015].
Available at: http://www.skaftkärr.fi/asukkaat/kaavoituskysymyksia

ERA17. For an energy-smart built environment 2017 [referenced 9.11.2015].
Available at: http://era17.fi/en/

Harju, I. 2015.
The quality and quantity of waste collected in a pipeline-based waste collection system : case Jätkäsaari and case Kalasatama. Master's Thesis, Lahti University of Applied Sciences. Available at: http://www.theseus.fi/handle/10024/94161

Heinonen, N. 2014.
Porvoon kaupungin kevyen liikenteen väylien kehittämissuunnitelma. Bachelor's Thesis, Lahti University of Applied Sciences. Available at: http://www.theseus.fi/handle/10024/79980

Montell, I. 2015.
Täydennysrakentamisen yleissuunnitelman ekotehokkuusselvitys: Tampereen Hakametsä. Bachelor's Thesis, Lahti University of Applied Sciences. Available at: http://www.theseus.fi/handle/10024/92832

Motiva. National climate and energy strategy [referenced 9.11.2015].
Available at: http://motiva.fi/files/9683/National_Energy_and_Climate_Strategy_2013.pdf

Motiva. Community planning [referenced 9.11.2015].
Available at: http://motiva.fi/en/public_sector/community_planning

SITRA. Climate change [referenced 9.11.2015].
Available at: http://www.sitra.fi/en/ecology/climate-change

Johanna Kilpi-Koski

Business Region Development Boosting Sustainable Growth

Lahti Region Development LADEC Ltd (LADEC) has a long, proven history of boosting growth companies, cooperating with research and educational organizations and other interest groups in Finland and abroad especially in the fields of Cleantech and Design. LADEC also supports regional plans, including the development plan for Lahti's trackside area near the city centre, as well as master plans and business concept plans for different areas and companies. The work has contained collaboration with official authorities, investors and local SMEs benefitting from the development projects.

LADEC has set up a team called The Business Region Development, aiming to find local development areas now and for future development to act as smart test beds for companies to pilot and demonstrate their sustainable and innovative technologies, products and services. The team is working very closely with public and private investors and is having a continuous dialogue with them, providing more possibilities for local companies to grow. There are two different types of reference sites:

- sites where products, services or technologies already exist and are in use (for example the Niemi campus and the Motorcycle Museum)
- sites where the competence of our region is manifested on the operational level (for example the Kujala Waste Treatment Centre)

Figure 1. The Motorcycle Museum (photos Finnish Motorcycle Museum)

Figure 2. Illustration of Niemi area (LADEC)

One good and concrete example of a reference site is the Motorcycle Museum located in Niemi, Lahti, where local companies and technology and service providers are demonstrating their innovative products and solutions. Cutting-edge technologies and progressive material solutions have been genuinely harnessed for everyday use. The Motorcycle Museum has a quick-charge post for electric cars; ground source heat pumps made by Oilon and solar panels from Oilon for heating the museum around the year; solutions for ventilation, cooling and heat recovery made by Pamon Oy; and LED products for lighting from Tomitec Oy. In addition, Purkupiha Oy provided recycled materials for building part of the museum. Now these companies have a local reference to show their customers. Recycling and green values can be seen and felt in the building.

The regional council of Päijät-Häme has been establishing an innovative planning process called “The Visionary Plan for Land Use”, to support city planning processes and ensure better co-ordination of regional planning, with involvement of stakeholders and professionals, to create a shared vision for selected areas, allowing for well-co-ordinated activities, with a long-term view for complex projects. Through the planning process, authorities will receive feedback on what kind of development topics should be included in the regional strategies to come and how the land use should be planned.

The idea of the innovative planning process is to bring different areas of expertise and stakeholders from various organisations for informal mind mapping before the legally valid city plans are done. This is an improvement as neighbouring municipalities will benefit from co-operation, forming a better connected area with coherent value proposition to inhabitants, businesses and visitors. The planning process is being tested and improved, particularly in relation to involvement with stakeholder groups: the official city planners, land and real estate owners, entrepreneurs, companies and citizens. The communication differs a lot from the official process, and thus it is possible to generate innovation without limits or legal restrictions. Hence, the planning process is more anticipatory and allows more innovative layout and implementation and saves resources. That is to say the Innovation plan allows the evolution of the urban planning process, subsuming the SMEs’ innovation of new low carbon Smart City technologies.

LADEC’s Business Region Development team is supporting and implementing this innovative planning process by organizing workshops and seminars and inviting companies and other stakeholder groups to participate in these mind mapping events. LADEC has an active and continuous dialogue with the regional council of Päijät-Häme on how to develop our region and especially brownfield areas around railway stations.

The potential pilot and reference site for the innovative urban planning process and local technology providers will be the Lahti railway station and the area around it, so called brownfield. These areas around the station have been used for industry, and are being transitioned to residential use, becoming a mixture of residential, office and commercial areas with easy access for citizen and tourists. The development targets in this area are sustainable and efficient energy solutions, mobility, and parking and ICT solutions. We hope that the railway station will be a smart test bed for local companies and service providers and the area will turn into a low-carbon hub which is connected to the rest of the city by smart infrastructure connections.

Figure 3. Illustration of railway stations of Lahti region and its brownfields (Jalo Toivio)

Essi Malinen and Eeva Aarrevaara

Water Protection in Lahti

Lahti is a city with many small lakes, and it is nationally famous for its good-quality groundwater. Protection of groundwater is a major priority in Lahti, since Lahti is close to one of Finland's largest areas of groundwater. A lot has also been done to protect surface waters in Lahti. Lake Vesijärvi is a great example of lake restoration and protection projects in Finland.

This article is based on a Master's thesis, the objective of which is to bring together all information about the water protection in Lahti, covering both surface waters and groundwater. The research problem is how the focus of water conservation has changed in Lahti from the 1970s until today. The theory part presents the water policy in Europe and in Finland, and introduces the water bodies in the Lahti region. The qualitative research was implemented by a face-to-face interview and analysis of existing data. Two local experts from the water protection field were selected for the interview. One of them is Ismo Malin, the current Water Protection Manager in the Lahti Region Environmental Services. The second interviewee is Juha Keto, retired limnologist, who worked for the City of Lahti from 1975 until 2008, and has done his life's work in water protection.

Water protection aims to prevent and reduce anthropogenic pollution of the waters. European water legislation started in 1975 when standards were compiled for rivers and lakes used for drinking water abstraction. Common objectives about a better status of waters are set throughout the European Union by the Water Framework Directive (2000/60/EC). The objectives of the directive are to prevent and reduce pollution, to promote sustainable water usage and environmental protection, to improve aquatic ecosystems and to mitigate the effects of floods and droughts. The ultimate objective is to achieve a good ecological and chemical status for all waters by 2015. Other related directives are the Groundwater Directive (2006/118/EC), which aims to prevent the deterioration of the status of all bodies of groundwater, and the Floods Directive, which aims at the reduction of the adverse consequences of floods for human health, the environment, cultural heritage and economic activity associated with floods. The Commission also launched a Blueprint to Safeguard Europe's Water Resources in November 2012. The aim of the Blueprint is to remove the barriers that hinder actions to protect Europe's water resources.

In Finland the protection of water began to be developed in the early 1960s, when the Water Act (1961/264) and the Water Decree (1962/282) came into force. Water protection objectives

Figure 1. Lake Vesijärvi (photo Essi Malinen)

in Finland have been defined by the Water Protection Policy Outlines, the Environmental Protection Act (527/2014) and the Water Act (587/2011). The EU Water Framework Directive has been implemented with regulations, which are the Act on Water Resources Management (1299/2004), the Decree on Water Resources Management Regions (1303/2004) and the Decree on Water Resources Management (1040/2006). There is also the Decree on Substances Dangerous and Harmful to the Aquatic Environment (1022/2006). The Groundwater Directive has been implemented nationally with the changes done to the above mentioned four regulations.

There have been great improvements in legislation and ecological classification of lakes. This has brought new bureaucracy and paper work, but some money has been budgeted for the measures.

The First Salpausselkä ridge is the main divider of surface waters in the Lahti Region. Surface waters on the north side of Salpausselkä belong to the Kymijoki River watercourse and those on the south to the Porvoonjoki River watercourse. Human activity has greatly influenced the surface waters of Lahti, which are presented in Figure 2. Especially Lake Vesijärvi and the Porvoonjoki River have suffered greatly from the effluent

Figure 2. Lakes, ponds, kettle holes, rivers and brooks in Lahti (modified from a map, Urban Laboratory for Sustainable Development 2014)

load in the past. Increased eutrophication has limited the recreational use of many small lakes during the last decades. Settlements, industrial and commercial activity, woods and farmlands and also the atmosphere all affect the lakes.

The water quality of lakes Alasenjärvi, Joutjärvi, Kymijärvi and Mytäjäinen has been monitored with varying intensity since the early 1970s, and other lakes were included to the monitoring programme later. Only Kintterönlampi and Kaarlampi have been excluded. The Lahti Region Environmental Services is responsible for the monitoring of lakes and the biggest ditches. The management activities of the lakes include management fishing, oxygenation when needed, the removal of aquatic plants and the stocking of predatory fish. The water body management of the Lahti Region Environmental Services is part of the Vesijärvi programme. The goal of the programme is to maintain and improve the condition of Lake Vesijärvi and other smaller water bodies in the region.

Most of the groundwater in Lahti is formed in the First Salpausselkä, and also Renkomäki and Kunnas are important groundwater areas. Part of the groundwater is formed from Lake Vesijärvi through infiltration into the Salpausselkä ridge. Lahti's groundwater areas, formation areas and springs are presented in Figure 3. There are six groundwater areas in Lahti, five of which belong to the first class (areas important for water supply) and one to the second class (areas suitable for water use). During the inventory of springs in Lahti, 37 springs were found, 17 of which were in a natural state.

According to the expert interview, the main problem of water protection in the 1970s was excessive load, and the objective was to remove it from the watercourses. The principle of the national water conservation program was that all waste water had to be treated with enhanced, third-degree cleaning, which also included the removal of phosphorus, by the end of the year 1975. Lahti got a treatment plant in 1975. The real estates and the catchment areas of all the lakes were also reviewed in the 1970s. In the 70s and especially in the 80s, attention started to be drawn also to acidification.

Lake Vesijärvi had changed to a nutrient-rich lake dominated by blue-green algae. Small lakes had also changed in the 70s, and at the beginning of the 80s all of them were full of blue-green algae. During the 80s, the main problem was the blue-green algae, which was caused by eutrophication. This chronic problem could no longer be resolved by any of the basic water protection measures. Then oxidations were started, and eventually they improved the state of small lakes so much that the blue-green algae problems disappeared.

The environmental monitoring began in the 1970s and since then there has been a water monitoring program for the lakes of Lahti. The intensive groundwater monitoring started in 1989, and it was expanded in the early 90s. The main means to restore bodies of water were oxidation, direct in-lake precipitation of phosphorus and removal of sediment, or dredging, which started to be tested. In general, there was not much money allocated for water conservation measures.

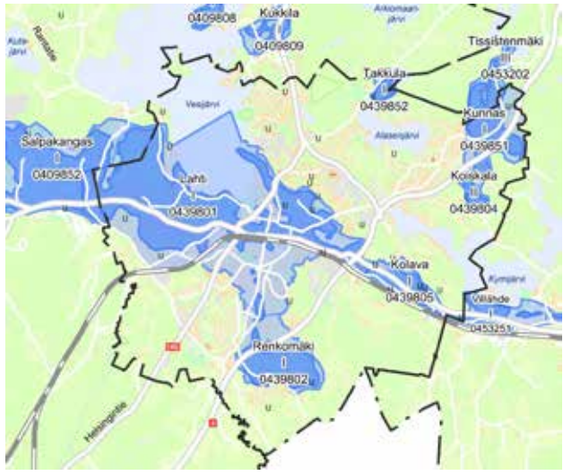


Figure 3. Groundwater areas (light blue), groundwater formation areas (dark blue) and springs (U) in Lahti. Class I: areas important for water supply, class II: areas suitable for water use, class III: other groundwater areas (partially copied from a groundwater map, City of Lahti 2013)

The 1980s and 90s were decades of ecological restoration or biomanipulation in Lake Vesijärvi. In the 90s, biomanipulation extended to the small lakes, and at the same time, winter oxidations were done. The water in Lake Vesijärvi was already clear in 1990, and the good years with no notable blue-green algae problems continued until 1997. Good results were also achieved in other lakes, with the exception of Kymijärvi, so that they no longer had to be constantly oxidized.

Usually municipalities do not take an active role in the remediation or management of water bodies, because the municipal sector is not in charge of water conservation. That is why the model of Lahti is special. Lahti and two neighbouring municipalities, Nastola and Hollola, have formed the Lahti Region Environmental Services unit, which monitors water quality in these three municipalities by taking water samples. The attitude and willingness to invest in water protection is very good, and a steady financing has been obtained from The Lake Vesijärvi Foundation.

The whole idea of biomanipulation was imported and developed to Finland by Juha Keto and Ilkka Sammalkorpi, and good results have been received. Lahti is committed to management fishing, and oxidation is also done in the summer. There are many restoration methods where Lahti has been among the pioneers, including direct precipitations of phosphorus, oxidation with the Mixox water oxidant device, biomanipulation (fishing), Velox oxygen lime experiment, barley straw bale experiment, PHOSLOCK treatment, and also the drainage of a lake.

Lahti was the most blue-green algae dominated area in Finland in the late 70s and early 80s, but this is no longer the case. However, the most important lakes are only in a satisfactory state and there is still a long way to achieve a good state. The lakes of the urban areas are multi-loaded, and they cannot be completely remediated.

Future challenges of water protection include climate change, population growth and changes in the attitudes of the municipality. Climate change increases the load, since a lot of load can be caused by the increased winter floods. In Lahti, almost all the suitable areas for the construction are already zoned and built, so poorer and poorer areas have been taken into use. Also, if the economic situation of the municipalities gets worse, the environmental sector is the first to suffer.

References

A Blueprint to Safeguard Europe's Water Resources. 2012. [referenced 10 October 2015].
Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52012DC0673.

City of Lahti. 2014. Lahden seudun järvet ja joet [referenced 13 October 2015].
Available at: http://www.lahti.fi/www/cms.nsf/pages/63BED6ADFBCD9943C2256F5E0034E07B

City of Lahti. Pohjavedet [referenced 12 October 2015].
Available at: http://www.lahti.fi/www/cms.nsf/subpages/
asuminenjaymparistoymparistonsuojelupohjavedet

European Commission. 2014. Water [referenced 10 October 2015].
Available at: http://ec.europa.eu/environment/water/index_en.htm

Keto, J. 2014. Limnologist. Interview 11 December 2014.

Lahden seudun ympäristöpalvelut. Vesistöt [referenced 13 October 2015].
Available at: http://www.lahdenseudunluonto.fi/lahden-seudun-luonto/vesistot

Lahti, Tekninen ja ympäristötoimiala, Valvonta- ja ympäristökeskus. 2005.
Lahden lähteet. Available at: http://www.lahti.fi/www/images.nsf/files/8116E1E98A727F60C2257A
EF002F78BB/$file/L%C3%A4hdejulkaisu%202005%20nettiversio.pdf

Malin, I. 2014.
Water Protection Manager. Interview 11 December 2014.

Mäenpää, M. & Tolonen, S. (eds.) 2011.
Kooste vesienhoitoalueiden vesienhoitosuunnitelmista
vuoteen 2015. The Finnish Environment 23/2011. Finnish Environment Institute (SYKE). Available
at: https://helda.helsinki.fi/handle/10138/37044

Penttinen, K. & Niinimäki, J. 2010.
Vesiensuojelun perusteet ja vesistöjen kunnostus. Opetushallitus.

The second Lahti Cleantech Annual Review consists of eleven articles written by Lahti University of Applied Science's experts from the Faculty of Technology and Institute of Design, and Lahti UAS partners from the City of Lahti and Lahti Region Development LADEC Ltd. The aim of the review is to present the latest interesting research and development projects in the field of cleantech. The focus of the review is on work related to material efficiency, energy efficiency and sustainable urban environment, which are the main themes of cleantech activities at Lahti UAS.

Lahti Cleantech Annual Review supports communication with Lahti UAS's partner universities, companies and other stakeholders, and it is also a part of implementation of cleantech themes in the Lahti UAS RD and educational operations. This Lahti Cleantech Annual Review is published as a part of REISKA: New Business Using Resource Efficiency project funded by the European Regional Development Fund.

LAMK
Lahden ammattikorkeakoulu
Lahti University of Applied Sciences

PÄIJÄT-HÄMEEN LIITTO

Leverage from the EU 2007–2013

European Union
European Regional Development Fund

The publication series of Lahti University of Applied Sciences, part 14
ISSN 2342-7493 (print) ISSN 2342-7507 (net publication)
ISBN 978-951-827-243-7