Ria Gynther (ed.)

LAB Sustainability Annual Review 2020

The Publication Series of LAB University of Applied Sciences, part 10

LAB University of Applied Sciences

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Kati Manskinen

Foreword

This review presents the latest interesting research, development and innovation activities in the context of sustainable circular economy. The articles are written by experts from the LAB University of Applied Sciences and its partners. Our aim is to promote the transition towards a sustainable carbon-neutral circular economy together with other operators. We actively take part in the development of new technologies, digital solutions and functions that enable sustainable material cycles, and improve resource efficiency. Moreover, we promote the construction of sustainable communities and operating models that support them. (LAB 2020.)

In March 2020, the European Commission published a new revised Circular Economy Action Plan as part of the Communication on a European Green Deal from December 2019. The key focus will be on the sustainable use of natural resources in resource-intensive sectors, where the potential for circularity is high. The Commission will launch concrete actions on electronics and ICT; batteries and vehicles; packaging; plastics and textiles; construction and buildings; food; water and nutrients (EC 2020). In this review, you will find our solutions supporting the European Circular Economy targets.

The first article of this review, written by Ms. Ida Määttä, Ms. Jenni Syvänne and Dr. Costanza, presents some interesting results of plastic trials run by a novel pilot-scale recycling equipment as well as some results about identifying microplastics in solid samples. The second article written by Dr. Marko Hyvärinen and Mr. Ville Puhakka describes the opportunities to valorize new products from waste fractions which originate from the crushing and screening of construction and demolition wastes. The circularity of industrial residues is also highlighted in the article of Ms. Anni Orola, Mr. Samuli Joensuu and Ms. Sanna-Mari Wallin, who share their experience in the utilization of ashes from a power plant as an earth construction agent in a forest road. In their article, they also provide interesting life-cycle assessment results, which support the utilization of ashes in such end-use.

The sustainable use of natural resources is not achieved only by increasing the circularity of materials but also by shifting from ownership to the use of services. Increasing the interest of sharing and service economy is pointed out by Ms. Kaisa Tuominen, who in her article introduces sharing economy trials carried out in rural areas. Sustainable services are also promoted in the international Interreg Europe funded project, called CECI (Citizen Involvement in Circular Economy Implementation), which is led by LAB (University of Applied Sciences). The CECI project is presented in the article written by Ms. Katerina Medkova, Ms. Johanna Snell and

Ms. Marjut Villanen. In their article, they also describe some recognized Good Practices supporting citizens to adopt sustainable consumption habits and services. One such Good Practice is the Personal Carbon Trading (PCT) scheme for citizens, which is developed and piloted in the city of Lahti as a part of the CitiCAP (Citizens' cap-and-trade co-created) project. The PCT system is presented in the article written by Mr. Niko Suvisilta, Dr. Ville Uusitalo and Ms. Elisa Uusitalo.

Bio-based solutions are in the core of circular economy (EEA 2018). The article written by Ms. Sanna-Mari Wallin, Dr. Sami Luste and Ms. Jaana Myllyluoma presents new bioeconomy opportunities launched in the city of Heinola. In their article, they also present a new kind of co-operation model for regional development. Biomass plays also a significant role in the regional energy sector, as shown in the article of Ms. Katerina Medkova, Mr. Paavo Lähteenaro and Ms. Maarit Virtanen. In their article, they highlight the fact that emission reductions should be increasingly based on clean electrification with wind energy, solar power, and heat pumps.

In order to fully support the regional growth and transition towards circular economy, LAB is investing in new circular economy and energy facilities for companies. Mr. Vilppu Eloranta et al. present in their article some new laboratory equipment, as well as the energy model built in our Lahti campus. New facilities will offer also for our students a chance to strengthen their skills in real-life environment. The changing world is challenging the education, as pointed out in the article written by Ms. Pia Haapea et al. In their interesting article, they introduce the development of circular economy education in the collaboration between Finnish universities of applied sciences.

Finally, circular economy is promoted through European and national policies. Recently, many regional visions and roadmaps towards a circular economy have been published. Furthermore, these roadmaps have been concretized through many regional projects as also described above. However, in promoting regional roadmaps, the systematic approach and measurable objectives are still lacking in many cases. In the last article of this review, Dr. Satu Rinkinen, Dr. Kati Manskinen and Dr. Tero Rantala illustrate the next steps forward from strategic regional circular economy roadmaps through international examples and a new picture.

I warmly thank all the authors who made it possible to publish this review once again. I express my gratitude to the editor of the review Ms. Ria Gynther and to Ms. Tuija Marila for correcting the English language of the articles. I hope that this review gives you some new insights and further ideas in the transition towards a circular economy society.

Lahti, 24 November, 2020

Dr. Kati Manskinen
RDI Director
Circular Economy
LAB University of Applied Sciences

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Ida Määttä, Jenni Syvänne, Costanza Scopetani

Circular Economy Solutions for Micro and Recycled Plastics

The ERDF (European Regional Development Fund) funded Kiemura project is based on the need to find solutions to the challenges related to the recycling of plastics, and the identification of microplastics (LAB 2020). In 2018, the European Commission released a European Strategy for Plastics in a Circular Economy. The aim of the plastics strategy is to reduce the problems caused by plastic waste. The strategy actions are to increase the efficiency of recovering and recycling plastics, and to improve product design. At the same time, it creates conditions for new circular economy innovations and business opportunities. (European Commission 2018.)

The EU Plastic Strategy, the tightening of national recycling targets for plastic packaging, and challenges related to microplastics contribute to the need for new ways to process plastics and solutions to recycle materials (VTT 2020). Increasing the recycling of plastics means that ever dirtier and lower quality plastic fractions need to be taken into the recycling processes. The targets are ambitious and a lot of work needs to be done to achieve them.

Microplastics can be found virtually everywhere, but their effects on organisms, human health and the environment are not yet precisely known. Research on microplastics has so far focused mostly on the study of different aquatic environments. The quantity, quality and the environmental impact of microplastics in solids, such as compost or soil cannot be reliably assessed.

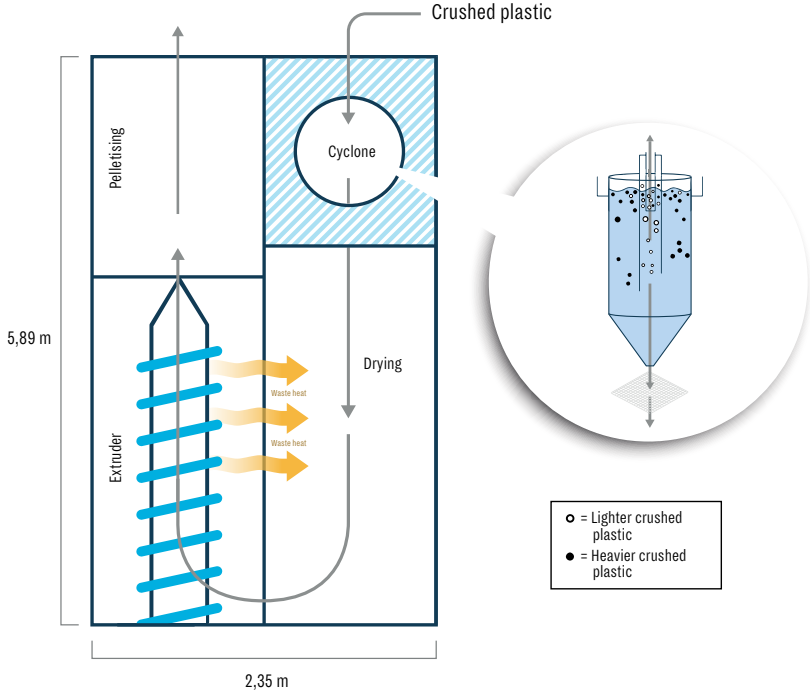
The main aim of the Kiemura project is to improve recycling of plastics and to develop a method for analysing and identifying microplastics in solid materials. The aim is also to support the growth of new plastics recycling business.

Picture 1. The need to increase recycling of plastics means that ever dirtier and lower quality plastic fractions need to be taken into the recycling processes (Picture: Niko Rintala)

Recycling and washing line for plastics

The focus of the Kiemura project is on plastic fractions that currently go to incineration. This plastic waste is usually heterogeneous and might contain, for example, food residues, metal parts, or paper labels (PlasticsEurope 2020). Project activities include the construction and testing of recycling and washing line for plastics, which includes washing, sorting and drying equipment for plastics and a twin screw extruder.

The sorting unit is based on a hydrocyclone that is used for sorting plastic particles based on density. Plastics are sorted in order to increase the quality and the value of recycled materials. The washing and recycling line was designed on a pilot scale to allow it to be used in larger test runs simulating industrial production. Smaller, mobile equipment (crushing, washing and separating units) also allow the line to be exported closer to the customer, which reduces the logistics costs of recycling materials.



Picture 2. A simplified picture of the washing and recycling line (Picture: Oona Rouhiainen)

Recycling tests have been carried out in cooperation with companies. The unit is used for testing the suitability of different plastic fractions and their mixtures to make plastic granules from recycled plastics. The aim was to produce information on the mechanical recycling of plastics. Agricultural plastics, plastics separated from municipal solid waste, production waste and WEEE (Waste Electrical and Electronic Equipment) plastics were examined. The plastics were processed on a recycling line, and the samples were injection molded. The samples were examined for their mechanical and physical properties. Some of the fractions examined were purified and recycled without significant deterioration in properties. The more mixed fractions had lower results. Density-based separation is not able to distinguish all the fractions from each other, but for some fractions it is well suited.

Packaging with plastic-coated labels

One of the first test runs was made with packaging with plastic-coated labels. Paper labels were coated with polypropylene (PP) and glued to the packages. The main goal was to test whether the labels could be removed from the packages. In preliminary tests on a laboratory scale, the labels detached well with organic solvents. On a larger scale with a washing unit there were problems with detaching the labels. It seemed that the temperature was too low, and the concentration of the washing liquid was not high enough.

Miscellaneous plastics separated from municipal solid waste

Municipal solid waste typically contains a significant amount of different plastics (PlasticsEurope 2020). It would help to achieve the recycling targets if these plastics could be separated and recycled, since most of these plastics are from packaging. The sample was pre-separated from municipal solid waste, and it contained mostly plastics. The fraction was washed, separated, dried and granulated. Mechanical properties were also tested. One separated fraction contained polyolefins (polyethylene PE and polypropylene PP), and the other mainly PET (polyethylenetrephtalate). To be useful, a polyolefin fraction should be separated into PE and PP fractions, but this was not possible with this separating unit. Tests with PET fraction are still ongoing.

Agricultural plastic films

One agricultural film fraction tested during the Kiemura project contained black polyethylene film. This film was crushed, washed, dried and granulated. Also, some basic mechanical tests were carried out. Crushing and washing were successful when the film was twisted into a tight package before crushing. Separation appeared an unnecessary process step, since it did not add any value to the recycling process. According to the test results, the quality of the recycled material was good, and it did not contain impurities. Based on the results achieved, this material is relatively easily recyclable.

Plastics from WEEE

WEEE contains a significant amount of plastics, such as polyolefins (PP and PE) and different technical plastics (for example polystyrene PS and acrylonitrile butadiene styrene ABS) (Raudaskoski et al. 2019). The main goal was to find out how much the fraction contains polyolefins and if it is possible to separate those with the Kiemura equipment. It was necessary to pre-separate the fraction due to metal, glass and stones. There were still some impurities after the plastic separation in one of the separated fractions. It was not possible to process this fraction further. The other separated fraction was expected to contain only polyolefins. However, the fraction contained miscellaneous plastics, and required a new separation phase using sink float separation. After the second separation, polyolefins were separated from the other plastics. The polyolefin fraction consisted mostly of PP, but included also some polyethylene particles.

Olive oil-based method for the extraction of microplastics

Pollution caused by plastics and microplastics (MPs) has recently gained scientific and media attention. MPs seem to be ubiquitous, and they have been found in marine, freshwater, terrestrial and in remote environments. Despite the large number of studies conducted on pollution caused by MPs, the extraction of microplastics from solid samples, such as soil, sediment and compost, is a scientific challenge that needs to be solved. There are no standardized and validated protocols for the extraction of MPs, and the existing methodologies are often unable to separate high density polymers. There are significant differences in methods when quantifying MPs in environmental samples, impeding a comparison between studies.

The aim of this research was to develop a safe, non-density-based method to extract MPs from solid matrices. Six different micro-polymers were chosen and added to soil and compost samples. Oil-based extracting techniques were tested using different kind of oils, and the most performing one turned out to be olive oil. The results show high recovery rates for all the six polymers tested, with the polymer density playing a small role in the process. (Scopetani et al. 2020.)

Picture 3. System composed of water, oil and microplastics floating in the oil phase (Picture: Costanza Scopetani)

Conclusion

Our ruling linear economy and throw-away culture treats plastic as a disposable material rather than a valuable resource to be harnessed, which is why plastics have been designed for single-use and low-cost production, and little consideration has been given to the possibility to recycle plastics (VTT 2020). New EU legislation imposes bans and restrictions on the use of some plastic products and tightens the recycling requirements. Meeting those recycling requirements will be challenging, and recycling techniques need a lot of development.

The Kiemura project provides tools to help us respond to the new regulations, promote low-carbon actions in the region, enable the development of new plastics recycling business, and support the utilization of byproducts. Research and development activities related to plastics support the Päijät-Häme region's circular economy aims. The microplastic analysis performed in the project provides information on the possible restrictions on the use of bioproducts caused by microplastics.

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Picture 1. Construction and demolition waste is important to the circular economy and has the potential of high recovery rate (Gaida 2018)

Marko Hyvärinen, Ville Puhakka

Sorting Waste from the Construction and Demolition Industry to New Products

The construction and demolition industry generates substantial waste streams annually. It totals approximately 36 % of all waste generated in the European Union (Tilastokeskus 2019). Thus, construction and demolition waste (CDW) is quite important also from the aspect of the circular economy. The EU Waste Framework Directive (WFD) requires a 70 % recovery of construction and demolition waste (CDW) from the year 2020 (European Commission 2016). Finland is lacking behind with a recovery rate bit over 50 % at the beginning of 2020. Even if some of the member states are achieving a 70 % recovery rate

there is still much room for improvement before the CDW management can be truly considered circular. (Salmenperä et al. 2016; Hyvärinen et al. 2020). These high recovery rates include low-grade recovery processes, such as backfilling, where the material is used to fill excavated areas. According to principles of the circular economy, products and materials should ideally stay in use for as long as possible. Backfilling, even if better than landfilling, is truly not a circular solution, since the waste is used to replace soil to fill excavated areas. (European environmental agency 2020). LAB University of Applied Sciences (LAB) and LUT University (LUT) are aiming to tackle this challenge in the ERDF-funded RAPA-project (Low-carbon products of construction and demolition waste reject). The RAPA-project develops the reuse for CDW screening reject, one of the biggest non-utilized waste fractions from buildings.

When a building is demolished, the waste goes through a mechanical sorting process to separate valuable materials for reuse. In an ideal scenario, minerals, metals, wood, glass, etc. are sorted at the construction site. Often coarse sorting is done with an excavator or a similar heavy machine, and the mixing of materials is inevitable. The remainder of the mixed CDW is crushed to ease the separation of metals and other valuables. Ferrous metals are separated with a magnetic drum while nonferrous metals go through the ECS-process. The material is then screened. Coarse mechanical crushing and screening processes generate huge amounts of mixed screening rejects. With the existing treatment processes, 20 to 40 % of treated CDW ends up as mixed reject without any other use than incineration. Screening rejects, the smallest particles that go through the screen, could contain traces of anything that has been in the building. The majority of the reject is stone-based materials, such as concrete and masonry, but small amounts of wood, plastic, plaster, ceramics, mineral wool, glass, etc. are also present. (Hyvärinen et al. 2020; Laine-Ylijoki et al. 2018).

Picture 2. Screening reject from sorting of mixed construction and demolition waste (Picture: Ville Puhakka)

Varying composition and harmful substances

Valuable fractions, such as metals and wood from CDW, have been recycled rather efficiently for some time. However, also less profitable streams, such as CDW reject, should be recycled to reach the WFD target of recycling. The main challenges in the recycling of screening reject are varying heterogeneous composition, organic material, and the possible presence of harmful substances. Screening reject is very heterogeneous, and its composition depends greatly on the source of the CDW, whether it is from construction, demolition, or renovation, used building materials and sorting methods. (Hyvärinen et al. 2020). Changes in the quality of the raw material are naturally visible in the end-product. The challenge is to find use where variation in the raw material is acceptable without compromising properties of the end-product, as long as this variation stays between the set boundaries.

At the moment, low but notable organic content limits the placement of CDW reject. Organic materials in CDW reject come mainly from wood, plastics, and paper used for covering plasterboards. Usually, organics total around 10% of the screening reject (Laine-Ylijoki et al. 2018). Earlier, CDW reject has either been placed on the landfill or incinerated, options that are neither green nor material efficient. The low organic and high mineral content of the reject means that it is not an efficient source of energy. Still reject contains too much organics to be placed on the landfill anymore according to the recently tightened legislation. Therefore, there is an urgent need for novel treatment methods, and the potential to advance the circular economy principles. (Hyvärinen et al. 2020).

Gypsum and forming sulfate from plasterboards cause challenges as well. During the sorting process, it gets ground into a fine powder that is difficult to separate efficiently. Sulfate or other harmful substances, such as coating materials, can then leach to the environment and cause harm. Leaching studies are required to identify and prevent this behavior. More efficient separation of gypsum would require considerable changes to the sorting methods. An easier solution is to reuse the reject including gypsum, which could be possible without greater drawbacks in the end products. (López-Uceda et al. 2019).

Utilization of CDW reject in low-carbon products

The RAPA-project aims to develop new processing methods to increase the value and to create new products from mixed screening reject. This would make the reuse of the reject more tempting and promote reaching the WFD target. RAPA develops different solutions for the utilization of CDW-reject in low carbon products. Potential products could be molded concrete objects and recycled construction aggregates (RCA). CDW reject could also be used as a filler in composite materials (Hyvärinen et al. 2018). In concrete, reject could be used to replace rock material. Based on preliminary studies, it seems likely that recycled concrete would be lighter and softer than conventional concrete, and its usage should be chosen accordingly. Suitable product choices could

be roadblocks, noise barriers, benches, flowerpots, etc. The lighter weight of the recycled products means that they are easier to move if needed. RCA could be used for lightening material in road constructing and earthworks purposes, similarly to foam glass or clay aggregates currently in the market. By binding this reject powder into bigger aggregates, possible harmful substances could be capsulated inside the structures, which would prevent them from leaching into the environment. While the demand for construction aggregates is continuously increasing, these recycled low-carbon products could offer sustainable solutions.

Further information on the quantity, composition, and the handling of CDW screening residue is still required to develop the described recycling methods. CDW streams are heterogeneous and suitable treatment

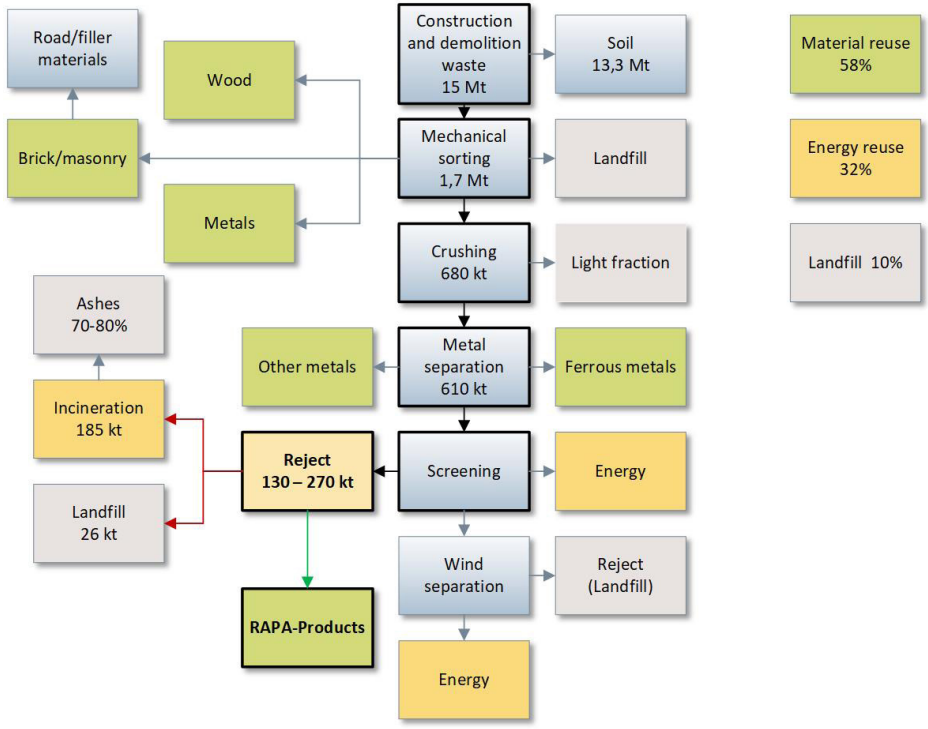

Figure 1. Estimated material streams for construction and demolition waste in Finland in 2015. The route to potential RAPA-products is highlighted (Figure: Ville Puhakka)

methods may need to be adapted according to the local waste characteristics. New products and processing methods need to be adaptable in big volumes to be considered as a solution. Alternatives for CDW reject disposal are needed urgently to meet the requirements of the waste framework directive. RAPA is studying methods for turning a significant waste stream that is currently an expense into attractive raw material for new low-carbon products. Using CDW-reject as raw material instead of natural rock would lower the need for quarrying, and thus reduce the slow depleting of non-renewable rock material and carbon emissions on the process.

Summary

Mechanical sorting of construction and demolition waste creates a significant amount of mixed reject that is challenging to recycle. This hampers in achieving the EU's 70 % recovery target for construction and demolition waste. Varying heterogeneous composition, sulfate, and possible harmful substances are currently the main obstacles preventing the reuse of the reject. LAB and LUT are collaborating in the RAPA-project to develop processing methods for reject to enable its use as raw material for new low-carbon products. The potential use for CDW could be found in the following applications: molded concrete products to replace rock-material, recycled light construction aggregates, or as filler in wood-plastic composites.

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Pictures

Picture 1. Gaida, M. 2018. 3688252. Pixabay. [Cited 26 Nov 2020]. Available at: https://pixabay.com/images/id-3688252/

Picture 1. ARVO-TUHKA pilot road in Päijät-Häme (Picture: Sanna-Mari Wallin)

Anni Orola, Samuli Joensuu, Sanna-Mari Wallin

New Value Chains of Utilizing Ash in Earth Construction – ARVO-TUHKA

ARVO-TUHKA project produces knowledge about the new possibilities of utilizing ash in earth construction in addition to promote the related co-operation, low-carbon mode of operation and business opportunities in the Päijät-Häme area. The aim is to share information about the legislation changes to the actors who work with ashes or earth construction, and to develop techno-economically profitable value chains for implementing new ash structures.

ARVO-TUHKA project is coordinated by LAB University of Applied Sciences, and implemented with Tapio Ltd. The project is financed by the Centre for Economic Development, Transport and the Environment of Päijät-Häme region, European Agricultural Fund for Rural Development.

Pilot road built with locally produced ash

Utilization of ash in new construction sites, such as private and forest roads, has been possible for a few years now in accordance with the MARA Decree (843/2017) set by the Government. The project built the first mix ash and crushed rock road in Päijät-Häme from the fly ashes of Lahti Energia Kymijärvi 3 plant. The project had co-operation with the local forestry association to find a suitable road that needs reconstruction. Pilot road is presented in Picture 1.

Ash fractionation tests

The quality of the ash is primarily affected by the fuel used in power and heat plants and its properties, as well as the combustion process. New mechanical and chemical ways of cleaning the already generated ash are constantly being studied. The project tested the air fractionations and electrostatic precipitators for two different fly ashes.

The environmental effects of wood ash mixture in the material used in forest road construction

There are 135 000 km of forest roads in Finland. The construction of new forest roads has been declined. Instead, the amount of the preparations of the forest roads has been increased. Wood ash could be used in road structures in order to improve the technical properties of low level roads. However, the environmental effects of the road structures that contain wood ash has not been well known.

Wood ash contains mineral nutrients, such as potassium (K), calcium (Ca), phosphorus (P), magnesium (Mg), manganese (Mn), iron (Fe), copper (Cu) and zinc (Zn) in almost the same proportion as found in the tree stand biomass. In addition to nutrients, wood ash also contains heavy metals, such as cadmium (Cd) and lead (Pb) that are potentially toxic to humans and to the forest flora and fauna. Although there is a lot of knowledge about wood ash itself, its physical and chemical properties, there has been a few data available whether the heavy metals of road structures containing wood ash will be leached and transported deeper down in the profile of forest road layers, which is very crucial when determining the environmental acceptability of wood ash as a road construction material.

The field experiment was established in 2011. The study site is located in Karstula in central Finland (N 62,51,3 E 24,26,13). The field experiment consists of 18 forest road sections, each 200-300 m that were handled with different mixtures of wood ash and gravel including control (gravel without ash). The treatments (with three replicates, except control n=1) were gravel with ash (gravel Ø 0-16 mm or 0-31,5 mm, 70 % or 85 % of weight and fly wood ash 15 % or 30 % of weight) and control (gravel Ø 0-16 mm or 0-31,5 mm without ash).

The environmental impact of the road structures was monitored from groundwater samples taken over a period of nine years. From each road section, the groundwater samples were collected from groundwater standpipes, which were located after the inventory of the direction of the flow of the groundwater. The groundwater samples were collected by pumping from the groundwater standpipes. The standpipe was pumped empty a day before the collection of the ordinary groundwater sample. The samples were stored at a cool temperature until analyzed with the standard methods.

During the first three years, the groundwater samples were taken five times per year from spring to autumn. No samples were taken in 2015-2017. From 2018 to 2020, two samples per section per year were taken. The chemical properties of groundwater, such as pH, alkalinity, conductivity and element concentrations were analyzed with the standard methods required in environmental

and waste legislation.

In this study, the main objective was to explore the environmental effects of wood ash in road structures on forest road. Based on the results of the study, the heavy metal content of the road structures containing wood ash as well as the environmental risk related to it can be managed. In this experiment, we demonstrated that the environmental effects of using ash are quite minimal when we use ash as a mixture material in road construction. During the whole period, the concentration of heavy metals was either very low or even under the detection limit, and very low compared to the background concentrations found in the nature. By using wood ash mixture with gravel, it is possible to improve the bearing capacity of the road and thus achieve a longer lifetime of the road.

Life cycle assessment based on the model road

Life cycle assessment was carried out based on the model road built in Urajärvi. The base of the road already existed, but it had to be renovated. The study was made according to the SFS-EN ISO 14040 (2006) and SFS-EN ISO 14044 (2018) standards. Two different scenarios were compared: road built with crushed rock and road built with ash mixed with crushed rock. The calculation was made using a functional unit of 100 m of road with a use phase of 20 years, which is an estimated time period between renovations. Different transportation distances were also assessed. The actual transportation distance of ash in the model road construction was 31 km, but also transportation distances of 50 km and 100 km were studied.

The system boundary of the study was cradle-to-gate with options including raw material extraction, transportation, building the road and the use phase. The avoided burden of landfilling the ash was also included. Leaching of the road and landfill was excluded. Based on the studies executed by Tapio Ltd during the ARVO-TUHKA project, it was assumed that the durability of the different road construction materials was similar. It was also assumed that the construction process was similar except for the mixing process of ash and crushed rock with excavator.

The assessed impact categories were Climate Change, Acidification and Resource use (energy carriers) (ARVO-TUHKA 2020). The results are presented in Figure 1. It should be noticed that the different impacts are measured in different units so they cannot be compared with each other.

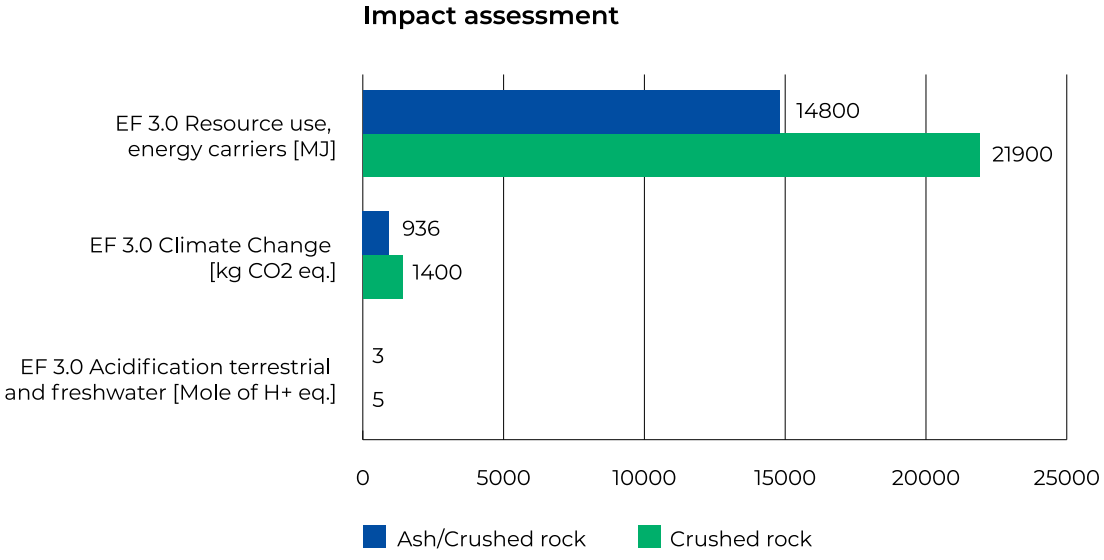

Figure 1. Results (Figure: Anni Orola)

Most of the impacts were caused by crushed rock production in both scenarios. Ash production did not cause any impacts, because the impacts were considered to be part of the previous life cycle. (ARVO-TUHKA 2020) Figures 2 and 3 present the share of the results in different life cycle phases.

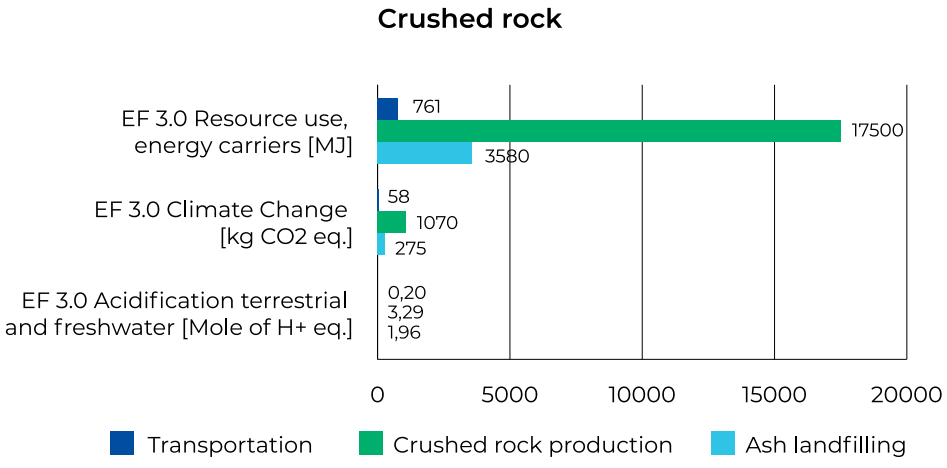

Figure 2. Share of results in Crushed rock scenario (Figure: Anni Orola)

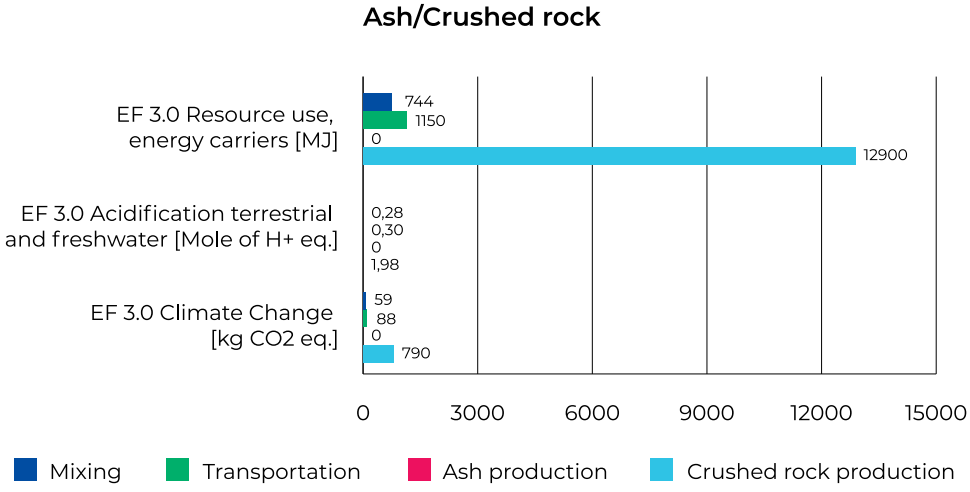

Figure 3. Share of results in Ash/Crushed rock scenario (Figure: Anni Orola)

The effects of change in the transportation distances on the total results in the different impact categories are presented in Figure 4. The impacts caused by the transportation distances are often considered to be minor in LCA compared to the other life cycle phases. In this case, the difference between the longest and shortest transportation distance is visible, but it is minor compared to the impacts of crushed rock production. (ARVO-TUHKA 2020)

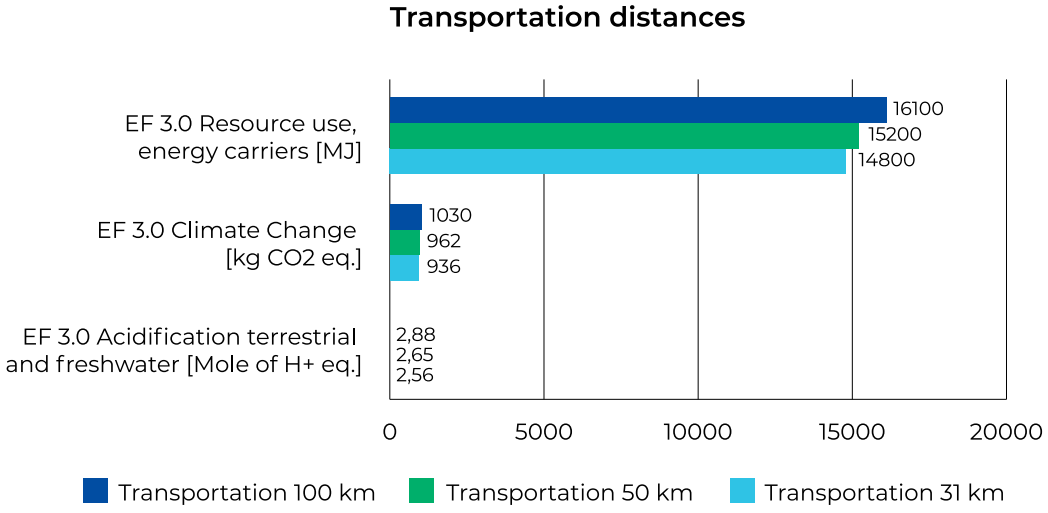

Figure 4. The effect of change in transportation distances on the total results in the different impact categories (Figure: Anni Orola)

The study implies that replacing part of the crushed rock with ash in road construction will help to reduce the use of fossil-based energy sources, and therefore also reduce acidification and the impacts on climate change. Since the renovation must be done every 20 to 30 years the results will multiply. The toxicity impacts caused by leaching of the road during the use phase should be further studied and compared. (ARVO-TUHKA 2020)

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Kaisa Tuominen

Creating Sharing Economy Services to Rural Päijät-Häme

Due to the urbanization megatrend, the countryside in Finland and globally has lost inhabitants, and services become more and more difficult to profit. This can be seen, for example, in the number of village shops, village schools and in the availability of health services in the public sector. The main reasons for people not to move to the countryside, are long distances, work-related challenges, for example difficulties to find work, and finding a suitable apartment (Älykylä 2020).

However, living in the countryside has started to interest people more during the coronavirus pandemic. Countryside provides free space, less stress and less people, which means that the spread of diseases is slow, and, during epidemics, such as the Covid-19, protection is easier. When big events were prohibited and restaurants and other services were closed, or people were afraid to use the services, the value of safe, natural and free space was risen. In spring 2020, people were moving to the countryside more than at the same time the previous year. During the pandemic, people were told to do remote work, which might change the way of working: the possibility to work remotely can increase moving to the countryside in the future, too. (Älykylä 2020; Kluukeri 2020.)

In the project Maallemuuttajat 2030 –Sharing and Service Economy in Rural Päijät-Häme (funded by the European Agricultural Fund for Rural Development), the aim is to increase knowledge about sharing economy possibilities in rural areas, and to start three sharing or service economy -based service trials in the Päijät-Häme region in 2020–2021. The inclusion of residents in the planning of service trials and service design was seen as an answer to how the services would fulfill local needs and be easy to use.

In this article, sharing economy in rural areas is discussed, and sharing economy trials that were started in the project, are introduced.

Attitudes towards sharing economy in rural areas

Sharing economy as a word is not familiar with countryside inhabitants, but it is carried out there in everyday life – some farmers rent their empty storages for leisure resident to store their boats, voluntary work parties working from farm to farm were usual before 2000's, and your neighbor lends tools or shares their extra apples or berries.

In the beginning of the Maallemuuttajat 2030 -project, the residents were asked, how they would like to participate in sharing

economy, and what services they would be willing to use. Would they be ready to rent their cars, boats, apartments or storages? Would they be willing to lend different tools for others? And what would they be willing to borrow themselves? What services were they interested in?

As a result, most inhabitants were interested to lend different tools and utilities that were not that expensive. For example, people were more willing to lend kitchen tools and other utilities for others rather than cars. Almost half of the respondents were interested in renting a boat, a trailer, a compact loader and/or cleaning tools for themselves. (Claudelin 2019.)

From services, buying local food and local food home delivery, a boat in common use, cleaning, gardening help, renovation service and IT-help were the most interesting services. People were also willing to offer places to sleep, storage space, cleaning help and animal care for others. (Claudelin 2019.) According to the results, the Maallemuuttajat 2030 -project held two info sessions about AirBnB -housing , which were very popular. After the sessions the number of AirBnB destinations in Päijät-Häme rose by 10 places.

Picture 1. AirBnB-info sessions rose interest in the residents of rural Päijät-Häme (Picture: Kaisa Tuominen)

When developing new services, sustainability and circular economy must be considered, so that Finland as a society can move towards carbon neutrality. Sharing economy services are an easy and visible way for ordinary citizens to take part in circular economy – also in the sparsely populated countryside.

Residents' lending service in the Asikkala Municipality

Asikkala is a small village in southern Finland with 8000 inhabitants. In the summertime, it is also a significant leisure apartment and tourism village within only 1.5 hours from Helsinki, the capital of Finland. Despite its small size, Asikkala is a developing municipality with active event organizers. Asikkala won the national "Finland's most mobile municipality" -competition in 2018.

The Maallemuuttajat 2030 -project together with the Asikkala Municipality decided to start a lending service trial. In a planning workshop, residents were asked where they would like to lend utilities, what the utilities would be, and what suspicions they had towards lending. The local library was seen as the most popular place to implement lending. The local library thought that the idea of a utility lending service would suit the library services, and might even bring new customers to the library as well.

After the first discussions with the library, the residents were asked more specifically what utilities they were willing to lend. The answers were varied; from chainsaws to sewing machines and skies. Considering the library's restrictions by space and safety, 15 utilities were decided to be collected for the lending service, which included: a sewing machine, a serger, a steam cleaner, a drill, a sander, a kids' travel cot, board games, a sled, different instruments, a plant dryer, a tent, a Trangia cooker, a backpack, a blender, a WOK-pan, skies and a thermal camera.

Collection of the utilities happened through a donation campaign. This was seen very natural for residents' lending service, which was from the beginning a communal act. The donation campaign succeeded well, and it had surprising social influences. The donators sense of belonging to their living environment strengthened, as well as the feeling of doing something for the common good. All the donated utilities were unused in the donator's household, and all the donations were in good condition. The donation campaign was dated at the same time when the COVID-19 pandemic had shut down most of the Finnish society, however, it probably did not influence the amount or quality of the donations.

During the donation campaign the residents were given the possibility to donate also other things that were not in the list, and therefore, an ice-cream making machine, a juice machine, and different sport equipment were given as a bonus for the lending service.

After the donation campaign, the utilities were tested and maintained. The project staff planned storage solutions, made agreements with the librarians, wrote guides for the utilities, and build a shelf for the library. A small-scale opening ceremony was held in June 2020, and local TV news and newspaper journalists were present to write articles.

Picture 2. Residents' lending service ready for its first customers (Picture: Kaisa Tuominen)

Municipality bikes in Hollola

Hollola is a qeographically widespread parish, with 24 000 residents. Hollola has a long history, it has been populated for over 8000 years, and was one of the first trading and living areas in Päijät-Häme. Nowadays, cultural events create appreciation for the old, with all the modern basic services including numerous nature routes and new schools. (Hollola 2020)

Hollola municipality had a need for village bikes that could be rented by residents and tourists. The bikes would help the residents and tourists to access new local places to visit. A new nature route with seven little villages was opened to Hollola before the Maallemuuttajat 2030 project, and the village bikes would support people to go there.

Hollola municipality had bought old bikes and repaired them, but they were missing the lending system. In this case, the library card was not an option because tourists

Picture 3. During summer 2020, five bikes were available in Hollola centrum, and five bikes were available in Kinnarin tila, a farm shop and a café, close the 7 villages route (Picture: Anna Claudelin)

wanted to be included. And, questions on responsibilities had to be solved: who would be in charge, if a bike broke or got stolen? What if the driver gets hurt at the same time?

The project staff in co-operation with municipal officials solved the questions. The lending system works by showing your ID and fulfilling a contact information form. Reservations are not used. If a bike breaks by accident, the bicycle user does not have to compensate the fixing expenses. If the bike gets broken or stolen purposely, the bicycle user will be contacted and held liable. The borrowers are told that the bikes are used ones, and the municipality cannot guarantee their functioning. Therefore, cycling is on the borrower's own responsibility. In the end of the summer, the bikes had got a lot of positive feedback.

Conclusion

In the Maallemuuttajat 2030 -project, it has been encouraging to see people's growing interest towards the sharing economy. The best result from the project has been ordinary people's "Thank you" after the info sessions, or reading positive comments about the service pilots in the social media. The culture of owning and the phrase "nothing gets better with lending it" have been strong especially in the countryside, but during the project those attitudes have gradually been changing, little by little.

Living in the countryside seems to interest people more and more, and I am honored to work for a project that makes countryside living more sustainable.

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Katerina Medkova, Johanna Snell, Marjut Villanen

Citizens Involvement in Regional Development

Regional development is all about cooperation with citizens, communities, municipalities and businesses. How to attract people to visit or move to a region and withhold their loyalty to stay, along with enhancing their wellbeing and capacity. This entails strengthening competitiveness and drawing businesses, not forgetting the main enabler, biodiversity and healthy nature. Together with regional actors across different sectors, such as academia, business, authorities and non-governmental organizations, the development benefits all parties towards more sustainable lifestyles and better living environments. (Regional Council of Päijät-Häme 2020.)

The Päijät-Häme Regional Development Strategy and Plan (2018–2021) is a key document to implement strategic goals and direct measures. The strategy defines three focus areas: increasing the region's attractiveness, adding value to different sectors, and experimenting with new growth areas. Besides, it entails three RIS3 Smart Specialization spearheads: circular economy, design and sports & experiences. (Regional Council of Päijät-Häme 2017.) One way to strengthen the strategy and its implementation is international cooperation. An exemplary project combining interregional cooperation and citizen engagement, is an Interreg Europe funded project CECI - Citizen involvement in circular economy implementation (Interreg Europe 2020a).

Picture 1. CECI - Citizen involvement in circular economy implementation project is funded by Interreg Europe (Picture: Petra Oravakangas)

The Päijät-Häme Circular Economy Roadmap is an essential part of the strategy, it describes the regional vision, the Päijät-Häme area as a "successful resource efficient region" in 2030, along with concrete measures to achieve common goals in terms of circular economy. One of the five goals set in the Roadmap is called "sharing economy generates new consumption models and business opportunities", in which the CECI's theme fits perfectly. (Regional Council of Päijät-Häme 2017.)

The CECI project enhances circular economy solutions focusing especially on sharing economy. The idea is to develop the local, regional and national cooperation, and support the regions to generate circular economy strategies and solutions, where citizens have a leading role.

CECI desires to lead citizens to adopt sustainable consumption habits and behaviour patterns. The project aims to promote new sustainable services, e.g. sharing economy, lengthening product life cycles through reuse, repair, remanufacturing and refurbishment. Furthermore, it strives to encourage citizens to reduce waste, save energy and think in a circular way. Changes in consumption patterns will stimulate the development of circular economy business models and create new jobs.

The interregional learning across participating regions from Finland (LAB as a leading partner), France, Czech Republic, Spain, Bulgaria and Belgium, takes place in thematic workshops and studies, round-table policy discussions and site visits. An important way to exchange knowledge and expertise goes on through the sharing of Good Practices, which helps to distribute circular solutions and save resources across Europe.

Picture 2. CECI promotes sharing and circular thinking (Pop & Zebra 2019)

CECI Good Practices

As a Good Practice can be regarded a service, toolkit or an app. It could also be seen as an example of a network, cooperation model, or a co-creating and educative event. (Interreg Europe 2020b.)

In CECI, the key criteria of the Good

Practices include (1) the promotion of circular economy, resource efficiency, and citizens' involvement, (2) it is successfully proven in practice, (3) it is easily adaptable to other European regions/cities, and (4) it is sustainable from an ecological, economic and social perspective. (Interreg Europe 2020b.)

The Good Practices identified in CECI are shared between partners and inspire the development of more relevant and efficient policies promoting citizen involvement in circular and sharing economy in CECI regions. Furthermore, the Good Practices are carefully evaluated by the Interreg Europe experts and, if accepted, they are published on the Policy Learning Platform. The freely accessible platform, operated by the Interreg Europe, offers proven and already tested solutions and examples to anyone interested. (Interreg Europe 2020c.)

Good Practices from Päijät-Häme, Finland

1. Personal Carbon Trading (PCT) scheme for citizens

One of the climate goals of the city of Lahti is to become carbon-neutral already by 2025. Traffic is the second-largest source of emissions in Lahti. To combat the traffic emissions, the CitiCAP project - citizens' cap and trade co-created implements a PCT scheme to promote and develop sustainable and low-carbon mobility in the city of Lahti. The project is the first in the world to target citizens' personal carbon trade. CitiCAP is included in SUMP – the Sustainable Urban Mobility Plan of Lahti. Furthermore, a 2.5 km smart bicycle highway with safe and comfortable cycling infrastructure will be built. New smart solutions, such as smart, energy-saving lighting, safe bicycle racks and info screens will be installed on the bicycle highway. (Interreg Europe 2020d; Lahti 2020; Smart & Clean Lahti 2020; Urban Innovation Actions 2020.)

The CitiCAP free mobile app allows the users to track and visualize their carbon footprint based on their real-time movement and the modes of mobility. The users can benefit from reducing their emissions from transportation by being rewarded with virtual coins. These coins can be exchanged to tickets for local busses or swimming halls, bags and pedestrian reflectors, etc. Based on the collected digital data on mobility, CitiCAP enables the advancement of new transport services for citizens, while reducing traffic emissions. At the same time, it triggers the citizens' attitude and behaviour towards more sustainable mobility. (Interreg Europe 2020d; Lahti 2020; Urban Innovation Actions 2020.)

2. Ridesharing for families, teams and communities

Carpooling, carsharing or ridesharing is a transport system based on shared use of private cars. This is very beneficial in terms of time, costs and emissions saved when bringing children to hobbies, commuters or for sports.

HyppääKyytiin (Hop in!) is a ridesharing mobile application. It is designed especially for people with a close-knit group around the same hobby, sport or travelling from or to the same destination. Through the app, one can order a ride, then the request is delivered to

suitable enrolled drivers based on the route and location requested. For example, the parents of children of the same sports team or a hobby location can provide rides to each other's children. Based on the experience, the app works best when people go to the same destination at a certain time (e.g. hobbies, events). (HyppääKyytiin 2020; Interreg Europe 2020e.)

This app takes ridesharing even further. The service is payable, and the money raised from it is mainly used for the common good, such as raising funds for sports teams. (HyppääKyytiin 2020.)

3. Puhdas Päijät-Häme, a modern environmental protection community

The Puhdas (clean) Päijät-Häme community aims to join forces for keeping the nature clean and free of rubbish. Littering is a big burden for the nature and the public economy. Although littering is already prohibited in the Finnish waste law, there are no real sanctions for violators of the law. More actions and discussions on this topic are therefore needed. (Aalto 2019.)

The community was founded in September 2019 and is led by a private individual. It is an environmental conservation community which works for a cleaner environment. Picking up litter is an easy and a very concrete environmental act. Also, making littering visible is an effective way to alter citizens attitudes. Working together for the good of nature strengthens the community and people's bond with the environment. (Aalto 2019.)

The community organizes different events and excursions for citizens and companies. The events are announced in social media and anyone can participate and volunteer just by showing up. Besides the cleaning actions, the community has supported science by delivering collected plastic caps for ecotoxicological research, and collaborated in creating educational materials for schools. (Aalto 2019; Facebook 2020a.)

All the events and tasks organized by the community are based on volunteer work. The community has received some help from local entrepreneurs, e.g. setting up a website, receiving trash bags and other equipment. (Aalto 2019.)

4. Kesanto (Fallow)

Kesanto is an outdoor venue located in the old industrial area of Sopenkorpi. It is within walking distance of the city centre, beside an old industrial train track. In the past, there have been various factories, today, e.g. flea markets, car repair shops and band rehearsal rooms. (Facebook 2020b; Lahola 2018, 2019.)

The father of the Kesanto idea, Eetu Floor, saw the area's potential. Together with his friend Max Hagelberg and the help of volunteers, the Kesanto event park was tided up and opened in May 2017. (Lahola 2018, 2019; Pursiainen 2020.)

The Kesanto can be described as a forgotten place that came back to life. It is a space that for many years was completely unknown to the residents and is now taken over in a new way. The basic idea has been to create a place, where any low-threshold event can be held. The Kesanto events calendar includes music from many different genres, poems, and yoga. The area is free for everyone to use, even outside the events. It is

Picture 3. Kesanto (Picture: Mira Rissanen)

a place for collectivity, in which anyone can participate in their own way. Trees growing between the train tracks and graffiti paintings on the walls create a unique atmosphere of Kesanto. (Lahola 2018, 2019.)

The purpose of Kesanto has not been cemented. There is a strong belief that the area will find its shape over the time, and hopes that the event park will contribute to the public's awareness and that the whole Sopenkorpi area could be seen as more than just an old and forgotten industrial district. (Uhrman 2018.)

Summary

The role of the citizens should be further emphasized in regional development. Empowering citizens, strengthening the cooperation, and involving everyone helps the transition towards sustainability and needed systemic change. Small steps will grow in time, so every move counts. Sharing of Good Practices is a very concrete way to transfer knowledge, and there as well, cooperation is essential to spread them widely on the local level to gain maximum benefits.

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Picture 2. Pop & Zebra. 2019. Share more, consume less. [Cited 13 Aug 2020]. Available at: https://unsplash.com/photos/kJZSIXoXrUE

Niko Suvisilta, Ville Uusitalo, Elisa Uusitalo

CitiCAP – Supporting Sustainable Mobility

Personal carbon trade has been seen as a potential policy method in the future for decreasing greenhouse gas emissions (Defra 2008). The CitiCAP (Citizens' cap-and-trade co-created) -project is piloting personal carbon trade (PCT) in mobility in the city of Lahti. The pilot is carried out using a mobile phone app which automatically records its users' mobility distances and modes (Kuokkanen et al. 2020). The aim is to test how a PCT system can be implemented in practice, and how valuable incentives through the PCT impact on the users' mobility behavior and on the emissions. The core idea is that carbon emissions have a price, and, by staying below a personal target emission level, the user can sell the extra emission rights, and earn virtual euros. Virtual euros can be used in the app's market place for products and services provided by the city of Lahti and by local companies.

The project entered its final year in 2020. While the project has been proceeding as planned since its start in 2018, the previous year and a half of the project has been very eventful. LAB University's role has been to supervise the app development, and to create small smart solutions, mainly for a smart bicycle road which has been built as a part of the project. LAB works with three companies who are responsible for the app development, and with the LUT University who is responsible for the development of the PCT scheme and the subsequent research. The software development partners are Moprim, GoodSign and Future Dialog. The app uses the Moprim SDK (Software Development Kit) which allows the app to recognize the user's movement type (walking, running, car, bus etc.) automatically. GoodSign provides the necessary backend services, housing the PCT scheme and the API's for data collection. Future Dialog is responsible for the frontend development as well as for the administration of the app.

Picture 1. User demonstrating the app in a live event. There have been surprisingly many senior citizens interested in the app, and the events have been a good way to introduce it to them (Picture: LADEC)

Like dancing on roses

In the beginning of 2020, the project was still suffering from the effect of the cyber-attack towards Lahti City's ICT systems. The emergency precaution of the city cut all the connections to their servers, and unfortunately all the CitiCAP servers were included. The developers of the CitiCAP-app could not access the project for several months, thus delaying the development of the iOS version. While we managed to get the Android version out in September 2019, the iOS version was ready for use in the spring of 2020. This delayed the research phase of the project by some months. The app received positive feedback despite its unfinished state, with most participants liking the theory, and the idea behind it. However, there have been many technical challenges, and the app has been improved through the project. Once we had both the android and the iOS versions ready for the official launch, the COVID-19 pandemic reached Finland.

The initial procedures against the pandemic were strict, and, in a consensus between all the partners, it was decided that pushing a launch event at that moment was not sensible. Therefore, the actual launch was postponed till May 2020. Understandably, we still could not push for live events, and we had to rely solely on social media and on other channels to gather more users. In addition, people's mobility behavior was quite unusual due to the COVID-19, which sets challenges for the research part. Figure 1 shows the average mobility distances and modes during spring and summer 2020. As can be seen in the figure, the mobility distances were significantly reduced especially during the spring due to the COVID-19, and it was dominated by passenger car usage. After reducing the COVID-19 limitations during the summer, the amounts of mobility rose again during the holiday season.

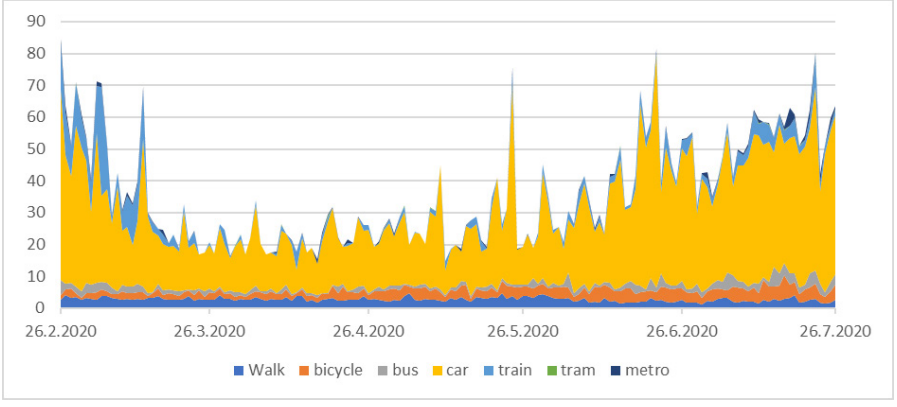


Figure 1. Mobility data collected (in kms) by the CitiCAP app during the COVID-19 in 2020 (Figure: Elisa Uusitalo)

Interesting times

Even though gathering the users has been difficult, the general attitude towards the app's PCT scheme has been positive and curious. The overall userbase has slowly but steadily grown throughout the year, and now we have approximately 300-500 active users per week. These are users that have cumulated the movement data in the past week. We also have received over 1500 installations during this year. Although the numbers are vastly different, they are better than the typical average in the market. An average commercial app often loses over 70% of its original users during its first three days, and 90% of the original users during the first month (Alhou et al. 2016, 423). Therefore, CitiCAP is doing well for its first year, considering it is not even designed for commercial purposes, but is strongly research focused with still development issues to be resolved. Cumulating more users during the COVID-19 pandemic with an app focused on sustainable mobility and encouraging cycling and walking, is a feat in itself. If this was a commercial app, development would continue in 2021, and with the knowledge and experience we have gathered, it could be further improved. The future of the app is, however, still open after the project has ended. It would be great to see it running at least through the green capital year of Lahti in 2021.

Showtime for the next gen

While LAB leads the software development of the CitiCAP app, we also are responsible for small smart solution pilots that are related to sustainability and mobility. LAB has an AI Lab, formed in 2018, consisting of student-level employees. The AI Lab has its own projects, but two trainees have been working on solutions for the CitiCAP project. They developed and tested a traffic counter that will be implemented on the smart bicycle road. The counter consists of a camera which takes photos, and a cloud-based machine learning AI that counts the walkers, cyclists, runners etc. from the pictures. They have also made a Lahti Fillari app for Android. This is a simple map app that lets you plan cycling routes. It has the entire Lahti City's bicycle infrastructure in it, which makes it usable only in Lahti. This was merely a proof concept, and would require upscaling for it to be an actual app, but it still has 144 active installations, which proves that you can go a long way in software development with only simplicity and a good UI.

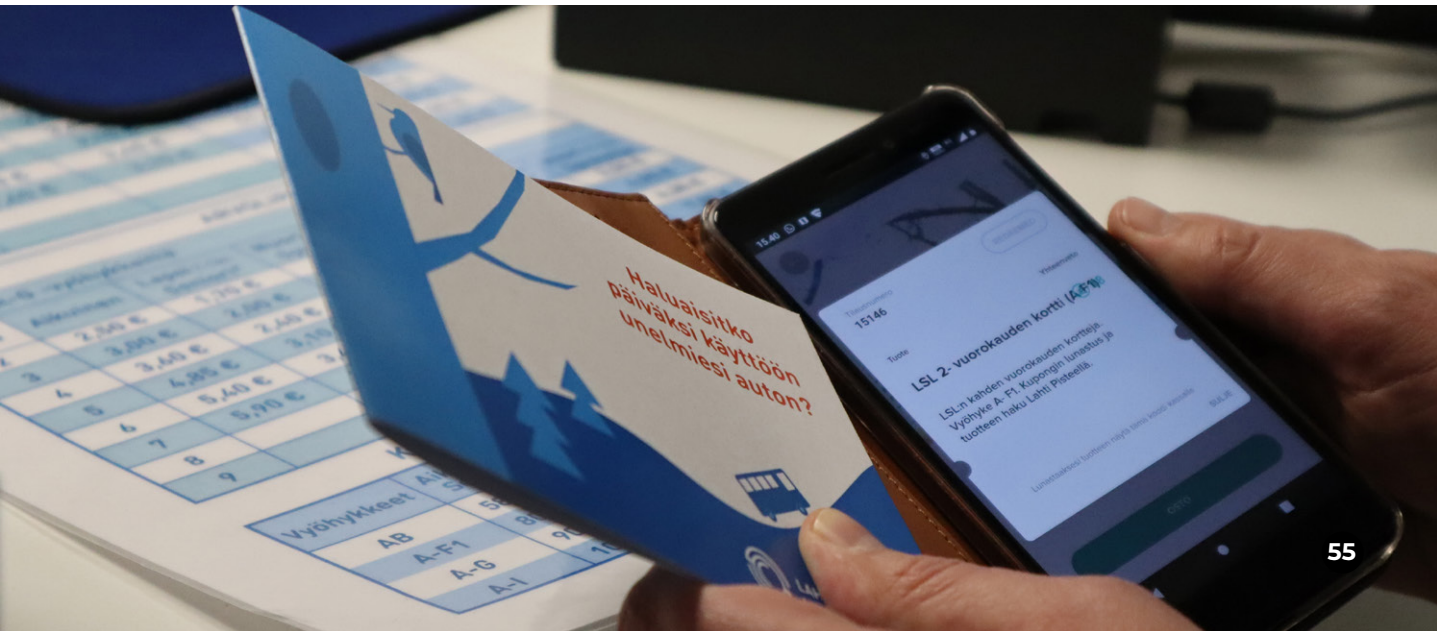
While we are waiting for the smart bicycle road to be finished, the AI Lab has taken three more tasks to try to squeeze in before the end of the project. The first task is auto censoring photos, such as blurring faces and the license plates on cars. Since the lab's focus is in machine learning, and especially in camera-based solutions, this is a good practice to learn to ensure anonymity, if the collected data is made available, for example, for research communities. Secondly, the app could act as a street-passing alert on pedestrian crossings without traffic lights. During autumn and winter, it is very difficult to see the street-passers, especially the ones without reflectors. We will test different methods to indicate for cars that there is someone passing or going to pass a street. The third possible solution is road condition tracking/surface monitoring. The AI Lab would use

computer vision to track the quality of road surface, identifying snow, ice, water puddles, potholes, cracks etc. This could be implemented into the smart cycling road as well, if we do not run out of time, that is. All these solutions can be developed further by the AI Lab's crew, even if the CitiCAP comes to conclusion, though different funding must be applied for, of course.

A peek into the future

Even though the project has had a rocky road this year, we are already looking forward to the future. Testing the PCT scheme has brought much visibility especially on international level, and much needed discussion on citizen level. Many cities are struggling with reducing mobility related emissions, and apps are seen as a possible part solution to encourage people to more sustainable mobility. Some large Finnish and international cities have shown their interest in starting their own PCT pilot or app development, and the CitiCAP crew has shared their experiences. LAB is also researching into upscaling the concept of the app and the challenges it provides, from both theoretical societies planning point of view, as well as from technical software development point of view. We are also analyzing the mobility data gathered by the app, and hope to see some impacts on the mobility emissions of the app users. Interesting questions are, for example, how the carbon price level impacts on the users' mobility.

Picture 2. Getting discounts from the app's marketplace has been a good way to attract more users. Products provided by Lahti City, such as bus tickets, are fully buyable via the app (Picture: LADEC)



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Sanna-Mari Wallin, Sami Luste, Jaana Myllyluoma

BIOHUB – New Kind of Concept for Regional Development

Over the past five years, the City of Heinola has focused to develop bioeconomy relating business in the area. The starting point was propitious: the region's bio-economy system includes 800 producers in primary production, 40 bioindustry companies, 15 bioindustry trade companies, more than 100 bio and circular economy ecosystem companies, and more than 1,000 jobs with a turnover of more than 300 MEUR.

A new type of co-operation with the Heinola city and the R&D facilities of LAB University of Applied Sciences is upgrading the regional development conventions to a new level. Co-operation with research, authorities and local enterprises is more straightforward, and the benefits on both sides arise, for example, from exploiting each other's networks. The new type of co-operation is expected to rise LAB`s role of development and the internationalization of the region's business community.

Picture 1. The moment of realization of the new type of regional development co-operation. Turo Kilpeläinen (Managing director of LAB) and Heikki Mäkelä (Business vitality leader of Heinola City) are signing an agreement regarding the new type of cooperation (Picture: Sanna-Mari Wallin)

City of Heinola is currently partnering in a multinational Interreg Europe project, SME POWER - SMEs powering a low carbon future. The overall aim of SME POWER is to ensure that the public policy for the low carbon economy and the relevant support instruments are better adapted to the needs of non-energy intensive SMEs, thus enabling them to be a key driver in the low carbon shift at regional and European levels. The specific policy instrument addressed by Heinola and the Päijät-Häme Region is the ERDF Sustainable growth and jobs programme. Senior Adviser Jaana Myllyluoma from the FCG Finnish Consulting Group coordinates the project on behalf of Heinola, with LAB experts providing their support along the way. Furthermore, the Finnish SME POWER team has established a joint regional energy stakeholder group with one of LAB's ongoing Interreg Europe projects with a similar focus, namely the RESINDUSTRY – Policies for Renewable Energy Sources in Industry.

The following chapters present two development projects already proceeding under the BioHub co-operation, the Green Growth Bio-village and the Extra CT – low carbon solutions from hot water extraction.

Green Growth Bio-village -project (2019-09-01 to 2021-08-31, 180 000€)

The project is coordinated by the city of Heinola and implemented by LAB and LUT. The project is financed by the ELY Centre of the Päijät-Häme region, Rural development funds.

The aim of the project is to pave the way for a major bio-refinery investment planned to be implemented in Heinola. The objective is to gather a straw supply network of local farmers for > 50 000 tons of straw per year. Moreover, sustainability-based operating instructions for the network as well as a web-based tool to maintain the actions are developed during the project. The research goal of the project is to answer the question: How is the straw-based delivery network implemented and maintained both sustainably and profitably for the first time in Finland?

Straw is an already existing agricultural by-product formed during the grain threshing. Most of it (80-90%) is left in the fields, when only 10-20% of straw is paled, collected and utilized as livestock bedding and roughage (Lötjönen et al. 2011). Straw can be utilized as energy or material/ intermediates. In this very case, straw is planned to be utilized for material purposes. The more refined the end product is, the more economical flexibility can be expected from the supply chain. The main difficulties regarding the operations of such supply chain, rise from the short period of time and unpredictable weather conditions during the autumns when most of the straw should be collected from the fields.

According to Välttilä et al. (2014), around 60-70% of farmers would be willing to sell at least part of the straw. According to the 900 farm contacts made during the project so far, around 90% of the farmers are ready the sell around half of their straw. The average amount in the Päijät-Häme region is 2,5 tons of straw per hectare (Pahkala et al. 2009). The field biomass utilization network will operate within a radius of approx. 100km from Heinola, in order to optimize the logistical costs (Jokela & Ahokas 2017; Skott 2011). The

Picture 2. Straw is agricultural by-product that can be utilized as energy or material. Most of the straw (80-90%) is left in the fields uncollected (Hermann & Richter 2016)

straw potential in the current logistic area is 340 000 tons of straw from which 17% is currently promised to be sold. The amount of already existing but so far unused hey (e.g. nature conservation fields, protection zones and set-aside fields) from the region would increase the potential up to 500 000 tons per year.

Essential for the utilization of straw pales is the dry storaging (<25% humidity) (Vanninen 2009) or molding opportunities, the cost-effectiveness of collection and logistics. Besides the financial margin of the supply chain, one important factor is the sustainable utilization of arable land. According to the literature from various sources, sustainable collection means that straw is not collected more often than every second year. More frequent collection may have a detrimental effect on the soil carbon content and on the growth condition (Hakala et al. 2016). The average straw yield leaves about 18 kg of nitrogen, 3 kg of phosphorus, 51 kg of potassium and 1200 kg of carbon per hectare (Rajala 2006). However, the reasoning behind the environmental sustainability for straw collection is also more closely studied by the LUT university.

Extra-CT – low carbon solutions from hot water extraction (2020-02-01 to 2021-08-31, 130 000 €)

The project is coordinated by the city of Heinola and implemented by LAB and LUT. The project is financed by the ELY -centre of the Päijät-Häme region and by the European

Regional Development Fund (ERDF).
The main goal of the Extra-CT project is to create preconditions for low-carbon hot water extraction based businesses in the bio- and circular economy ecosystem of the Heinola region. The project explores opportunities to increase the value added of sawdust, the by-product of the wood processing industry, and the technical and economic feasibility of a demonstration scale extraction plant. The partners involved in the project are the City of Heinola, LUT University and LAB University of Applied Sciences.

The mechanical forest industry is a major consumer of bio-based raw materials. Great volumes of saw dust is created as a by-product in the manufacturing processes of main products of the mechanical forest industry. This saw dust isn't currently utilized efficiently and therefore doesn't add value for the industry as whole. Depending on the quality of the sawn timber and the sawing method, about 10 chips are produced per cent of the volume of logs, which means more than three million cubic meters per year in Finland alone. Hence, there is a need for new processing methods that increase the commercial value of sawdust. In the recent years, a variety of wood has been tested with value-added extraction methods, the further development of which will enable new SMEs, for example for workshop production.
The project aims at finding out the possibilities to separate and fractionate wood polymeric compounds (hemicellulose and lignin) as selectively and effectively as possible in a hot water extraction-based process. The experimental extractions and differential tests are based on literature review and LUT University research expertise under conditions which, according to the study, would be best for the recovery of the various compounds. Also, the best rated extraction customization methods are tested. The project further explores the possibility of utilizing fiberboard process waters and solutions generated during the manufacturing process as sources of hemicellulose and lignin. The fiberboard samples taken at appropriate points in the production process will be analyzed.

The project will carry out a technical-economic feasibility and concept-level design of the extraction demo plant. The starting point is a concept that is financially viable as such. The demo facility is not just for the individual plant business but is also scalable for other use. The benefits of existing industrial by-product streams and processes in the extraction plant and the achievable benefits of the extraction plant for the industry in the area will be examined.

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Katerina Medkova, Paavo Lähteenaro, Maarit Virtanen

Renewable Energy Sources Enabling a Clean Energy Transition in Industry

The strategic target for Europe is to become climate-neutral by 2050 (European Commission 2020a, b). Finland has pledged to be carbon-neutral by 2035, Päijät-Häme region by 2030, and the City of Lahti has an even more ambitious goal to reach carbon neutrality by 2025, meaning twice as fast as the EU goal (Suomen ympäristökeskus 2020). This is in line with the European Green Capital 2021 award Lahti received (Lahti 2019).

Due to a cold climate, long distances and energy-intensive industry, the energy consumption per capita in Finland is among the highest in the European Union. Based on the Statistics Finland, the total estimation of energy consumption of industry and construction was 46.1% in 2019 (Statistics Finland 2020).

The EU's Renewable Energy Directive of 2009 set a binding target of at least 20% of its total energy needs to be fulfilled with renewable energy by 2020. In Finland, the target was set up to 38%. Finland exceeded its target by reaching over 40% share of renewable energy in 2018, leading into the second highest percentage of renewable energy among the EU countries. (Findicator 2019; Statistics Finland 2019.)

The revision of the Renewable Energy Directive in 2018 introduced a new target for 2030 of at least 32%, with a clause for a possible upwards revision by 2023 (European Commission 2020a, c). Among other actions, the National Energy and Climate Strategy of Finland for 2030 outlines the share of renewable energy in the end consumption to increase to approx. 50 %. At the same time, the increase in renewable energy use and energy efficiency measures will improve Finland's self-sufficiency regarding energy supply to 55 %. The Finnish industry is a significantly high energy consumer, therefore the shift from fossil fuels to renewables not only cuts the emissions but it is a vital investment in industry competitiveness, jobs and growth. (Valtioneuvosto 2017.)

Picture 1. RESINDUSTRY aims to develop the regional policies to boost the investments and integration of renewables in industry (Picture: Katerina Medkova)

Boosting the integration of renewables in industry

In Europe, the industry is the backbone of the economy. Therefore, the European Commission strongly supports the European industry in the transition towards a climate-neutral economy (European Commission 2020c). An Interreg Europe funded project RESINDUSTRY - Policies for Renewable Energy Sources in industry aims to develop the regional policies to boost the investments and integration of renewables in industry. The project's objective is to reinforce the industry competitiveness by lowering its energy bill, rising their energy independency, thus uncoupling their energy costs from geopolitical externalities. RESINDUSTRY consists of seven partners from the Czech Republic (Lead partner), Finland (LAB University of Applied Sciences), Spain, Estonia, Poland, Austria and Malta. (Interreg Europe 2020b.)

During the course of the project, all partners identify good practices of renewable energy sources used in the industry. A good practice is understood as, for instance, a technology that has been already used and tested elsewhere and could be adopted in other countries. Through the interregional exchange, these practices are then inspirational for creating targeted action plans in the project regions to boost the integration of renewables. All RESINDUSTRY good practices will be peer-reviewed and the selected ones will be assessed by the Interreg Europe experts. Based on the evaluation and relevance to the low-carbon economy theme, the good practices can be published on an open Policy Learning Platform and shared on the EU level (Interreg Europe 2020a, b).

Picture 2. Images of the many good practices identified in Päijät-Häme. Sources (in order from left to right, top to bottom): Kesko, Stora Enso, S Group, Finland (photographer: nicobackstrom.com), Lahti Energia, Labio, Lassi Häkkinen, Sebastian Ratu, Halton, St1.
(Picture: Oona Rouhiainen)

RESINDUSTRY Good Practices in Päijät-Häme

Good practices identified in the project were the following:

Lahti Energia Kymijärvi III: A large forest biomass plant for district heating replaces an older coal-powered plant in Lahti. Addition of heat capture in the plant's flue gas scrubber allows for very high efficiency, while also keeping down particle emissions by cleaning the plants exhaust gasses. (Wallin 2020.)

Fazer Lahti Xylitol factory: New xylitol factory will produce xylitol using oat hulls and

use its own waste product, “oat hull cakes” as a fuel in its boilers, providing process heat and steam for the factory and adjoining bakery.

Halton Marine Lahti: Halton’s factory in Lahti has committed to carbon neutrality by replacing its old natural gas heating with a system of ground heat pumps and heat wells which now provide the factory with all its heating. The system has an added benefit of being reversible and simultaneously being able to replace the plant’s old cooling system as well. (Kyllönen 2020.)

Stora Enso Heinola: Stora Enso pulp mill integrate has an investment in a novel wastewater treatment system which produces biogas directly from wastewater. Biogas production reduces the need for conventional wastewater treatment by 80 %, saving on energy and treatment chemicals. Biogas produced is burned directly in the plant’s bark boiler where it acts as a support fuel for the waste biomass such as bark, producing renewable electricity and heat for the integrates use while, at the same time, reducing the need for fossil support fuel. (Sillfors 2020.)

Suur-Savon Sähkö: Suur-Savon Sähkö has adopted a novel solar hybrid solar thermal and air heat pump system for district heating. The system, designed and delivered by Hollola based Calefa Oy, includes a field of solar collectors, heat from which is used by high-temperature heat pumps to heat district heating water or a heat storage tank. The heat pumps can also run from ambient air alone as air heat pumps to ensure the system can work around the clock and regardless of the weather. The system is used to cover summertime heat loads for which the company’s biomass heat plant is too large. (Calefa Oy 2020; Tykkyläinen 2020.)

Polttimo: Polttimo is the company behind Viking Malt factory in Lahti. Polttimo gets its process heat as a service from Lahti Energia, which runs the factory heating system, a biomass boiler capable of burning various biomass including forestry residue and agro-biomasses. Biomass replaced the old natural gas heating in 2016.

Hämeenmaan Kiinteistöt: Hämeenmaan Kiinteistöt owns the properties of S-Groups stores in Häme region. For common good and customer appeal, they have contracted from Lahti Energia multiple rooftop solar power plants for stores and other properties. Use of rooftop solar for stores is efficient as the large need for cooling coincides well with the peak production time of solar power, allowing for maximum utilization. (Tauriainen 2020.)

K-Group: Carbon neutral grocery store plan with heat capture and rooftop solar. Kesko plans for complete carbon neutrality by 2025. For grocery stores, this is to be achieved with extensive heat capture from refrigeration systems and rooftop solar power plants, of which Kesko already runs 34, totalling 12 MW. (Kokkonen 2020.)

Labio: Labio is a large composting plant handling the biowaste of the city of Lahti and surrounding areas. The plant produces biogas from a wide variety of biowaste from municipality and industry. The gas can all be sold into Gasum’s gas grid as all the heat required for the biogas reactors are provided by the composting of the waste. After the waste has been through the biogas reactor it is stored for composting. Biological

breakdown of the material produces plenty of heat which is captured from the buildings air outlets and used to heat the reactors and the premises with the aid of three large heat pumps. (Wassholm 2020.)

St1 Etanolix: A symbiosis of energy company St1 and beverage company Hartwall. Residues from Hartwell's drinks manufacturing are used as material for bioethanol production for use in transport fuels. (Pitkänen 2020.)

Summary

The identified good practices in Päijät-Häme are based mainly on the use of biomass with six out of the 10 cases utilizing various forms of bioenergy ranging from recovered heat from composting to producing biogas from industrial plant's wastewater. The utilisation of industrial side streams in energy production is an effective way of reducing emissions. Furthermore, the closing of material loops is in line with circular economy targets, especially in cases like Fazer, where residue oat

Picture 3. Emission reductions should be increasingly based on clean electrification with wind energy, solar power, and heat pumps (Adege 2013)

hull is first used for xylitol production and only after that as energy.

In the future, emission reductions should be increasingly based on clean electrification with wind energy, solar power, and heat pumps. At the national level, also nuclear energy is a part of the energy mix in Finland. As seen in the good practices, the use of solar energy is rapidly increasing in industries and also at private use. In addition to solar energy, heat pumps play an essential role in reducing industrial emissions. Energy sources for heat pumps include excess heat, ground heat and air to water. Since the Päijät-Häme region has vast groundwater reserves, groundwater energy might prove to be a viable energy solution, too.

Overall, the Päijät-Häme region has good examples of utilising clean energy solutions, but there is still a need to promote their use especially in SMEs besides larger industries. The EU green recovery package is expected to further boost energy investments benefiting both the industries and regional economy.

This article reflects the authors' views; the Interreg Europe programme authorities are not liable for any use that may be made of the information contained therein.

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LAB University of Applied Sciences Invests in Energy and Circular Economy Services

LAB University of Applied Sciences launched the "EKI – Energy and circular economy operating environments" project on September 1st, 2019 to extend its current laboratory facilities to include capabilities for energy and circular economy applications. LAB already has comprehensive wood, metal, machinery, material, furniture and construction technology laboratories. With the EKI project LAB now seeks to obtain more resources and expertise to provide new energy and circular economy services to companies, including piloting, testing, product development and demonstration facilities. The outcomes will simultaneously support environmental technology research and education now and in the future.

The new services will be positioned into service packages which answer to the needs of companies and are easily available. There is a long history of commercial customer services in LAB, and previously in Lahti University of Applied Sciences (Lahti UAS). For example, LAB has the only nonpartisan furniture testing laboratory in Finland, which was established in 1993 and is the basis of the current LAB Testing Services. LAB also already offers testing and R&D services for wood and material technologies. Therefore, investments in the operating environments in the field of energy and circular economy complement and strengthen the previous LAB Testing Services operations by expanding the service in offering a basis and expertise to new areas.

Investments in the operating environments in energy and circular economy will increase co-operation and services

In the project, significant investments are made for new equipment, methods, designing and construction of a new operating environment for the energy and circular economy. At least 50% of the utilization time of the investments to be made will be for business use, so it could be said that the operating environment of the new energy and circular economy is very business-oriented and serves and supports business operations well.

The needs of companies are also considered when making investments – a survey was conducted for companies and their

Picture 1. A LAB University of Applied Sciences project "EKI – Energy and circular economy operating environments" aims to develop testing and research resources to produce new energy and circular economy operating environments at the Niemi Campus in Lahti. The project is funded by the European Regional Development Fund (Leinonen 2019)

needs for various energy and circular economy services, and equipment are determined based on the survey and discussions. Joint investments located at the Lahti campus with companies are also possible, and the companies' willingness to invest together is surveyed with the same survey.

In the first step, investments that are approximately worth 274 000 € are made on the research devices needed in the operating environment of circular economy. The new investments for circular economy laboratory will include both a coarse workspace and an analytical laboratory. The procurement list includes e.g. a pyrolysis system, a biomaterial digestion system, a UV-VIS spectrophotometer, X-ray fluorescence equipment (XRF), an update for the Fourier transmission infrared system (FTIR), a gas chromatograph-mass spectrometer (GCMS), and lots of small laboratory equipment and devices.

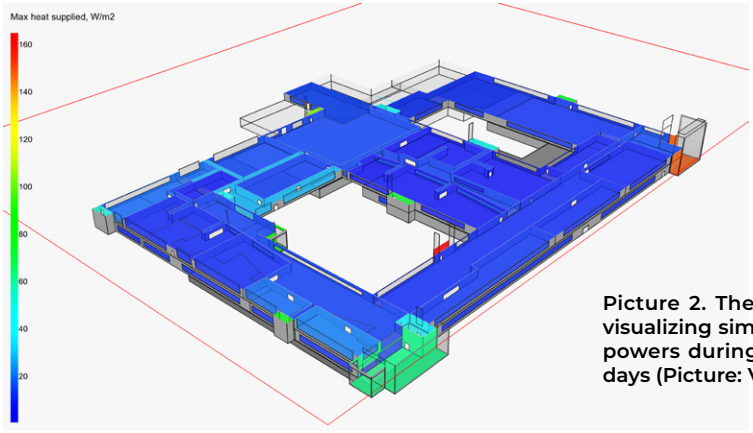
For example, pyrolysis equipment can be used to perform, among other things, laboratory-scale gasification of biomaterials and biochar modification. In addition, a digestion test place for biomaterials will be built in the coarse working space. In the coarse workspace, there is going to be also e.g. a magnetic separator and pelleting equipment, which will be purchased from another project.

An energy system model enables efficient concepting and piloting of sustainable energy innovations

Another part of the EKI project considers energy economy – it aims to develop an operational environment for sustainable energy related pilots and demonstrations. This enables research, development and business to reduce environmental impacts related to the energy use of buildings, and to find ways to turn large buildings from energy consumers into energy producers. Solutions for existing buildings are highly important in climate change mitigation because the renewal rate of Finnish buildings is only 1–2% per year (Motiva 2020). Heating in buildings alone corresponds to 21% of the total energy consumption in Finland, and, thus, contributes significantly to carbon emissions (SVT 2020).

In the first step, a new dynamic energy model for the M19 building at the Niemi Campus, Lahti was created using IDA Indoor Climate and Energy (ICE) software. The model is created based on the actual geometry and infrastructure of the building, supported by in-site measurements and general data available in literature. The model provides an insight into the dynamics of energy systems in buildings: for example, seasonal and periodical variations of temperatures, the energy consumptions for heating and cooling, local energy production figures, and energy-related greenhouse gas emissions. An example output of the energy model visualizing zone heating loads is shown in picture 2.

The energy model provides a modular platform to easily add or remove energy system components, and to assess the impacts of the modifications, and hence enables virtual concepting and piloting of technologies or products that aim to improve energy system efficiency in large buildings. The Niemi Campus acts as a reference for



Picture 2. The M19 energy model visualizing simulated zone heating powers during the coldest winter days (Picture: Vilppu Eloranta)

this cost-efficient test environment for new innovations. At the same time, it enables assessment of the potential to reduce greenhouse gas emissions. Any variable in the simulated energy system can be visualized. Figure 1 shows the results from a simulated mechanical ventilation system case that can be used as a baseline to benchmark the piloted technologies. If a technology or a product is proven successful in the modeling environment, it can possibly be applied in real buildings during the investment phase. In the second step, the focus will be on investments on hardware and software components related to improving the energy performance of buildings. They are used to construct the energy economy operating environment with measurement and simulation capabilities that serve new businesses, and to demonstrate issues related to energy efficiency, storage and production in large buildings. The main interests are in the inter-

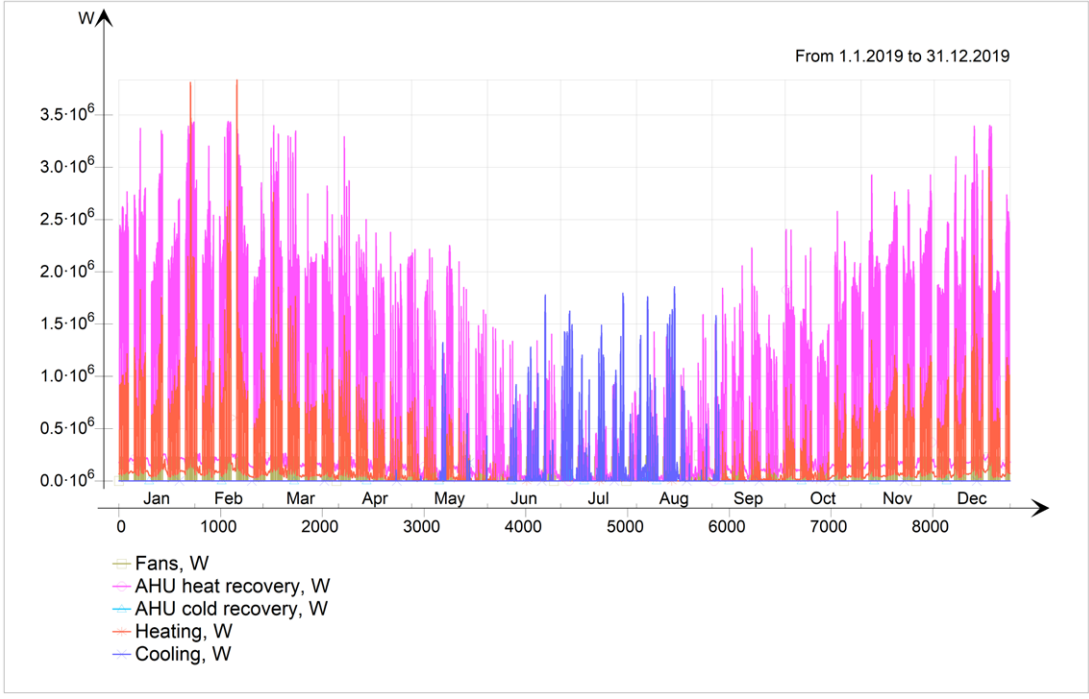


Figure 1. Exemplary simulation result of mechanical ventilation powers in the building. The data can be used in energy performance benchmarking (Figure: Vilppu Eloranta)

operability of components in buildings and networks, and in the potential to form a large building as an energy self-sufficient or even energy generating unit.

Research, development and innovation investments in the simulation environment encourage its use as a design and development platform in the future, whereby the connection and the optimization of additional components, such as various energy production units, storage methods or network interconnections, is straightforward. The capability to assess the impacts of climate change is an essential feature. The platform is to be made available online so that companies and others interested could utilize it also after the project.

Summary

The main objective of the "EKI – Energy and circular economy operating environments" project is to create an energy and circular economy operating environment at the Niemi Campus to support local business and to expand the services and facilities that LAB University of Applied Sciences can offer. There are two very ambitious main targets – to develop demonstrations and pilots of circular economy technology companies on the campus for the recycling of various materials and different technologies, and to develop an energy system platform that can be used to perform demonstrations and pilots of flexible production, storage and the distribution of renewable energy on small-scale.

Since the targets are very high, their implementation requires significant investments to both laboratory resources and people. Together with companies, investments are planned to develop the provided services and to advance education on circular economy and energy efficiency.

The EKI project includes significant investments on piloting machines, devices and energy-related platforms. With the new investments, the operating environment in energy and circular economy gain new facilities for versatile testing, piloting, research and demonstration in the field of energy and circular economy. The piloting environment includes laboratory-scale piloting, testing and research technologies of circular economy and energy systems. The demonstration environment is a platform where companies have opportunities to show their new solutions and technologies.

The project also aims to develop the Green Campus concept in Lahti, collecting the energy and circular economy knowledge and environments from the project, and applying them comprehensively into the Niemi Campus framework. "Green Campus" is a LUT Group concept to highlight, promote and advance sustainable solutions on campuses.

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Development of Circular Economy Education in Collaboration of Finnish Universities of Applied Sciences

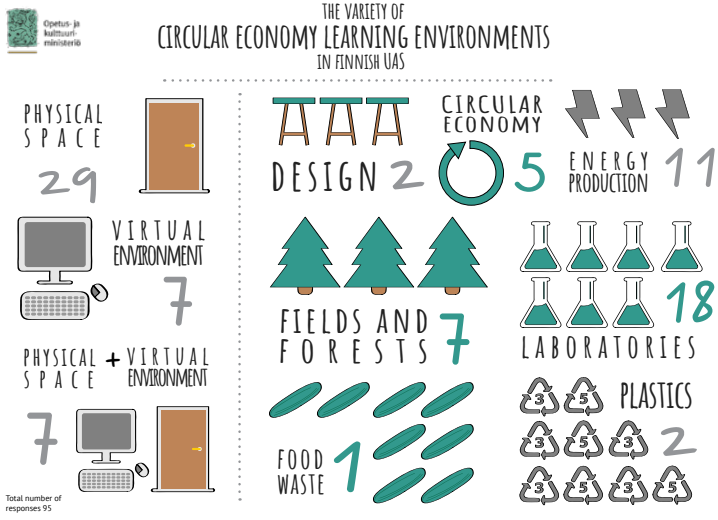
We are living in a time of accelerating change and in the middle of huge sustainability challenges, backed by threats of resource depletion, climate change, and the digital revolution. In recent years, circular economy has been offering new ways to shape the economy towards being more climate-neutral and sustainable. In 2020, the European Commission published a Circular Economy Action Plan to set the targets and the implementation for the transition actions (European Commission 2020). Alongside the EU level actions, the Finnish Innovation Fund Sitra has played a significant role in implementing the circular economy to be part of national level actions, private and public sector activities, as well as education. Finland's Road Map to Circular Economy 2.0 (Sitra 2019) and the Roadmaps for different sectors in industry were launched in June 2020 (Ministry of Economic Affairs and Employment 2020). Additionally, several regional development plans are under development or have been published, e.g. in the region of Päijät-Häme and in the City of Rovaniemi (Pöyry Finland Oy 2019).

Transition to Circular Economy Needs Capacity Building

The transition to a circular economy is a cross-cutting challenge for science and research, but also for professional skills and citizens' attitudes. In 2020, the Finnish Ministry of Education and Culture launched a sustainable development policy, in which the Ministry promised to take into consideration the goals and principles of sustainable development (Ministry of Education and Culture 2020). The policy is based on the United Nations's global sustainable development action programme, the 2030 Agenda (United Nations 2015). The development policy was launched to encourage the actors in the Ministry's administrative branch to promote and implement the goals determined in UN's 2030 Agenda actively.

Alongside the national level development actions, education was considered to be one

of the most critical ways to accelerate the transformation towards sustainability and circular economy (European Commission 2020). Education is a key tool when implementing new actions into the working life and into the society as a whole. Recently, circular economy has become attached in education alongside sustainable development. As the transition towards circular economy is a major challenge for organizations and citizens, the theme should be considered at all levels and in all fields of education. In Finnish UAS's, several actions have been implemented to develop circular economy to be part of the education especially in the fields of natural resources and engineering. For example, in Lapland UAS, circular economy was added into the engineering education via curricula reformation (Kantanen & Tyni 2020). However, several fields of education still lack the context of circular economy, and, therefore, the need for expertise is obvious due to the strong interdisciplinary nature of circular economy for example in the design, the economics and the health and social sectors. Universities of Applied Sciences are involved in solving the real challenges of circular economy and offer students the opportunity to reform their practices. From this perspective, in circular economy education, it is better to plan and support individual learning processes and dialogue than try to use pre-determined learning materials



Picture 1. Overview of the circular economy learning environments in Universities of Applied Sciences (Picture: Marketta Virta)

Circular economy needs co-operation

To support the transformation towards circular economy, 19 Finnish Universities of Applied Sciences got funding (app. 2.5 M€) from the Ministry of Education and Culture to develop circular economy education and collaboration in the Finnish UAS's (Figure 2). The Circular Economy Excellence in Finnish UASes -project started in 2018 and will be finished by the end of 2020. The project supports the transition towards circular economy at many levels. The aim of this project was to produce on-line learning material, develop learning methods and pedagogy to support multidisciplinary education and actions for circular economy. The project's website, www.kiertotalousamk.fi, provides more information about the project and its activities (KiertotalousAMK 2018).

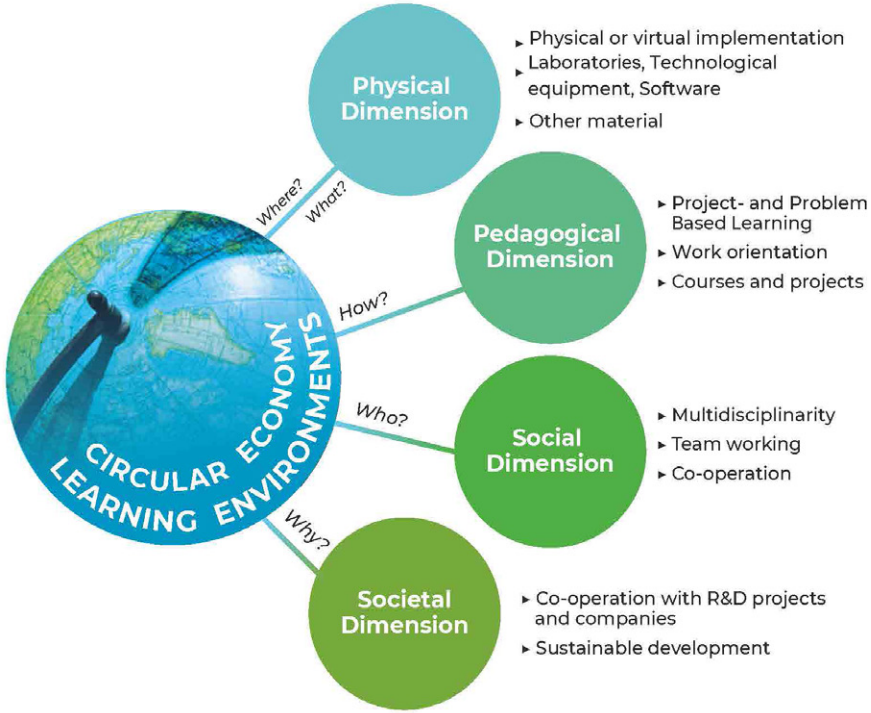
In addition, increasing the visibility of circular economy to students, staff, and partners was one aim of the project. In practice, this means that the project produces study materials and learning environments, creates new working methods, as well as distributes information about circular economy educational activities and knowledge.

Picture 2. Poster of the Circular Economy Excellence in Finnish UASes -project. The logos of all the participants are presented in the poster (Picture: KiertotalousAMK)

Sharing of knowledge and best practices

The most part of the work has been done in developing new teaching materials. More than 200 ECTS of educational materials has been produced in Finnish, English, and Swedish by the multidisciplinary teams. The teams were formed of more than a hundred teachers, whose expertise covered the nine cross-cutting themes of circular economy (technological and biological cycles, digitalization, design, business models, regulation and the impact of policy making) containing more than 30 subthemes. The developed material will be available to all and published in the Library of Open Educational Resources (OER) -portal during autumn 2020. OER is a portal where anyone can search for and share open educational resources from all levels of education. This platform was also developed and established by CSC – IT Center for Science, via the funding provided by the Ministry of Education and Culture. (OER 2019.) All material will be published under a Creative Commons license which allows free non-commercial use for anyone interested in circular economy (Creative Commons 2020). Two other work packages concentrate on the share of know-how and on the development of learning environments and pedagogical methods which will be applied for education. This is important because the knowledge capability building of circular economy needs more holistic approaches. Deeper integration of circular economy into the activities of Universities of Applied Sciences requires not only the development of individual courses and methods, but also the construction of various circular economy learning paths. Due to the different kinds of learning environments, it was noticed that different learning environments can strongly support the capacity building of circular economy. The learning environments can be implemented in different ways, from a laboratory to a course entity or virtual learning platforms.

The development of the concept of a circular economy learning environment (Picture 3) was one the project's outcomes. The concept will be utilized more comprehensively in the development of teaching circular economy, taking into account the material, pedagogical, social and societal dimensions.



Picture 3. Draft of the concept of learning environments for circular economy. It includes four dimensions: physical, pedagogical, social and societal (Picture: Pia Haapea)

Impacts on many levels

One important impact of the project is a teacher's grass-root level involvement. The motivation and the commitment of the teachers increased due to the inclusive process and the meaningfulness of the co-operation to develop one's own work. The project, as a whole, was a learning process, due to participation and knowledge sharing. Each participating organization has witnessed one or more of the following phenomena:

- New people (teachers) for RDI projects.
- The learning curve has been high. The understanding of one teacher and expert has increased due to knowledge sharing.
- Development and strengthening of networks, new and old, even interorganizational

- New bilateral and multilateral connections between UAS
- Stronger in-house (each UAS) grassroot level forces to promote CE (and SDG) agenda in each organization and in the surrounding society
- Discussing the Sustainable Development Goals and Carbon Neutral Economy in a systematic level.
- A wide range of joint publications. During the project's timeframe more than over 100 publications, mainly in Open Source Platforms.
- Student knowledge about circular economy and its possibilities have increased.

There were also several indirect impacts:

- Companies that participated as commissioners for pilots got new ideas and learned about circular economy
- Front runner circular economy companies gained visibility as their approach was made known
- Companies that operate in the partner UAS regions got local circular economy R&D expertise that supports them in the future challenges.

Co-operation will continue

One of the main benefits of this project has been the new co-operation networks and co-operative ways of working. The project has brought together teachers and experts around Finland having the same objective; to increase and implement the knowledge on sustainability and circular economy. The co-operation will definitely continue in different ways in the future: in social media platforms and in projects as well as in co-operation in education as a whole. These networks not only serve its members, but also increase and maintain the development of circular economy in many perspectives and directions with many stakeholders. The network has also influenced political decision-making, for example through Arene – the Rectors' Conference of Finnish Universities of Applied Sciences, by developing the sustainability indicators to be used to achieve carbon neutrality goals.

There is still a lot of work to be done during autumn 2020 for finalizing this project. The main outputs, the study materials produced during the project will be published. In addition, many seminars and webinars will be arranged in the participating Universities of Applied Sciences to implement the outcomes achieved.

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Measurable Steps Forward from Strategic Regional Circular Economy Roadmaps

Roadmaps have become a widely used way to create visions and set long-term development targets for chosen strategic priority areas. In Päijät-Häme, roadmap work related to regional smart specialisation strategy has been active throughout 2020 (Regional Council of Päijät-Häme 2020). Developing roadmaps in cooperation with regional stakeholders has been presented internationally as a good practice to define common vision and regional objectives for strategic priority areas (Interreg Europe 2020a).

In the Netherlands – a forerunner country in circular economy and sustainability transition research – roadmaps have been successfully exploited in, for example, the city of Amsterdam (Cramer 2020). It seems that the strength and the most evident utility of the roadmaps lies in the participatory nature of the roadmap process, and in the shared and defined future vision, which will guide the development activities. But how to continue the regional implementation work after the common vision has been crystallized and the overall objectives defined in the form of roadmaps? How to take concrete steps forwards from the roadmap phase?

Defining concrete actions through action plans

Creating regional roadmaps for chosen priority areas in cooperation with regional stakeholders can help build common understanding about the significance of the priority areas and the desired direction of change. However, the existence of these roadmaps alone does not necessarily generate actions that would strive towards the upper-level objectives described in the roadmaps. Thus, it is important to consider already during the roadmap process how the roadmap can be implemented in the region, and how the different regional actors can be committed as active implementers and realizers of the roadmap.

In Päijät-Häme, a step forward from the circular economy roadmap has already been taken in the form of Bio-based Circular Economy Action plan (Interreg Europe 2020b). The action plan concretizes bio-based circular economy objectives of the roadmap by packaging them into four regional level actions.

Picture 1. Developing roadmaps in cooperation with regional stakeholders is a good way to define common vision and regional objectives (Åkerblom 2019)

These actions define the regional long-term objectives for enhancing bio-based circular economy, but they do not yet include concrete measurable objectives that would enable to monitor and evaluate on a regular basis how these objectives have been reached. From the managerial perspective, it would be essential to create an appropriate measuring system in order to be able to manage the development activities towards the desired outcomes.

Measurable objectives as a basis for monitoring and evaluation

Examples of ambitious measurable objectives set for circular economy already exist. There are European cities, such as Utrecht in the Netherlands, where the shift from linear economy towards circular economy has been advanced by political commitment to measurable regional objectives. For example, one of the objectives of the city of Utrecht is that 33% of public procurements must meet the defined circular economy criteria in 2023. Also, concrete financial indicators are set to monitor the change. From 2016 to 2018 the amount of public circular economy procurements in Utrecht have increased from 4 million euros to 27 million euros. (Hoffmann 2019.) Committing to circular economy criteria in public procurement at municipality level spurs the development of new circular economy businesses. It is also a good example of how private sector development can be supported by public sector activities.

Picture 2. Päijät-Häme region has an action plan for the sustainable management and use of biological resources (Meyer 2010)

Figure 1 presents the idea of the process of moving from upper-level visions and long-term objectives to concrete actions and measurable objectives and effects. The figure is designed for the circular economy priority area, and therefore the main objective is to move from linear economy to circular economy – but the basic idea applies for any other thematic priority area.

The left-side point of the triangle consists of the politically defined future vision and desired direction of change. In societies, these are based on the values guiding the political decision making, and, are therefore fundamentally based on also the values of the citizens (voters). Commonly defined and agreed vision also engages the different parties to the process. In the next phase, the long-term upper-level objectives are defined in the form of roadmaps. Roadmaps are followed by action plans that concretize the development activities and the measurable objectives that are regularly monitored and evaluated.

The right-side part of the triangle consists of the measuring system and the relevant indicators designed for the whole process of change. The monitoring system should be designed keeping in mind both the upper-level objectives and the operational level measurable objectives. The needed information can be not only quantitative but

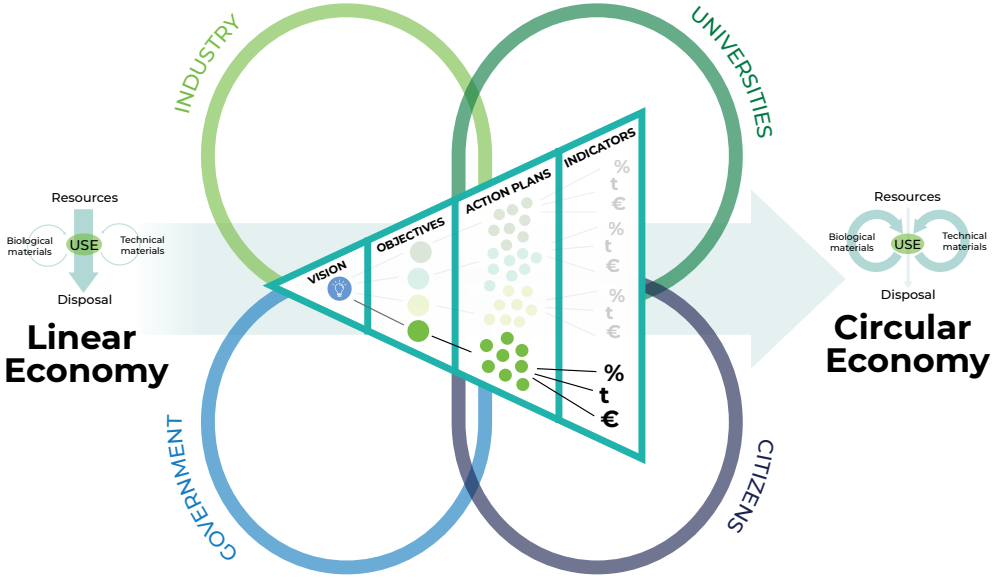

Figure 1. Transition from linear economy to circular economy (Figure: Oona Rouhiainen)

also qualitative by nature. Regional development related strategic priority areas are often cross-cutting by nature, combining different areas of expertise and multiple fields of businesses and industries. Therefore, it is difficult – if not impossible – to identify the effects of a particular priority area related development activities with traditional regional development indicators.

While developing the measurement system to support the management and evaluation of the circular economy activities, it is important to keep in mind that the upper-level objectives and operational level measurement activities should be in line. This means for example that the regional level targets should provide guidelines for the operational level measurement activities of the different actors. While both the upper-level objectives and the operational level measurement activities are in line, the measurement of the operational level targets and goals can also support the upper-level design of circular economy policies and practices (Rantala and Ukko 2019). The evaluation of operational targets and goals could be seen as upper-level design mechanisms, as presented.

It should be noted that unlike in this simplified figure, in real-life this process is not as linear as presented here. The different phases overlap and have feedback loops. The Quadruple Helix context in which this process is carried out also highlights the participatory and co-operative nature of the process.

Conclusions

As noted above, international examples of ambitious target-setting already exist. However, both at national and regional level the specification of these objectives is a political task at root (Edquist 2019). Initiating systemic change in a society is never an easy task. It requires at least creating desired visions of the future, target-setting, practical experiments, activation and involvement of different actors (particularly private sector organisations) and holistic decision-making as well as improving governance and management practices so that public sector activities would support each other's objectives rather than work against each other (Fagerberg 2018, 1573–1574; Loorbach 2010, 173; Walrave et al. 2018, 109).

What are the concrete steps forward after finalizing regional roadmaps for different priority areas? How to combine the upper-level visions to practical level development activities? Measurable objectives can help monitoring the direction of change in order to evaluate if the actions carried out are leading towards the desired direction. Roadmaps can present the "big picture" and strategic main goals but more detailed measurable objectives, designed for each priority area can, at their best, make the change more manageable from the regional development point of view.

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Pictures

Picture 1: Åkerblom, L. 2019. 4401704. Pixabay. [Cited 9.11.2020] Available at: https://pixabay.com/images/id-4401704/

Picture 2: Meyer, A. 2010. 3795989. Pixabay. [Cited 9.11.2020] Available at: https://pixabay.com/images/id-3795989/

The theme of this publication is sustainability, which is one of the four focus areas at LAB University of Applied Sciences (LAB). This publication contains eleven articles written by experts and students from LAB and its partners. This review presents the latest interesting research, development and innovation activities in the context of sustainable circular economy.

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