



# New ways of thinking will lead to economic growth

## **Bringing circular economy into play**

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*Finland is making the transition to the circular economy on the basis of new business and technology innovations. New solutions are enabling cross-cutting, systematic changes in society. Partnerships and cooperation play a key role in generating innovations. Resolving the challenges of the circular economy is an everyday activity at VTT. It is time to move from words to deeds at all levels of society.*

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### **Transition towards circular economy through new operating models**

Value will be created in the circular economy by new, attractive service solutions making everyday life easier and transforming business activities. Low emission production will be enabled by smart energy solutions and advanced processes and methods. Waste and industrial side streams will become a material resource. Combined with new thinking and operating models and networked business models, technology has enabled a huge step to be taken towards the circular economy, benefiting companies, consumers, society and the environment.

We shall make the transition to circular economy through concrete actions. Here we present five solutions for making the transition to circular economy:

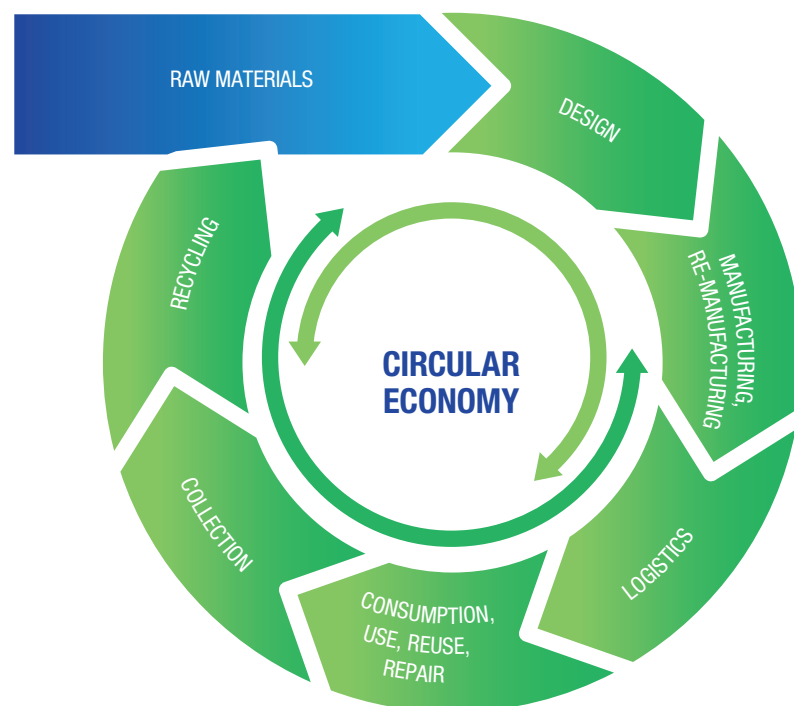
1. By making the transition from the sale of consumer goods to service provision, we can reduce the consumption of materials and gain new business opportunities, while promoting development of the domestic service sector. Piloting will provide a rapid and cost-effective route to testing new business models.
2. A reduction in food waste will be enabled by new practices and technologies in primary production, the food industry, retail and consumption. This will result in improved material efficiency and create business opportunities for domestic industry.

3. As digitalisation progresses, electronics will be integrated into new types of products. Traditional mechanical recycling processes are ill-suited to the recycling of increasingly complex products. Recycling concepts based on combined technologies enhance the recovery of metals and other raw materials, and reduce waste.
4. 3D printing is creating new business in the production of objects and parts for machines, reducing materials consumption and creating new opportunities for the processing of metals.
5. By promoting shared use of vehicles and mobility service concepts, which combine several forms of mobility and adapt to consumer needs, the degree of utilisation of vehicles will be increased while reducing the consumption of natural resources by traffic.

## Smart circular economy concerns every company

Grasping the opportunities of circular economy will require a systemic transformation in society, including new kinds of business competencies, new technological solutions, changes in mindsets and structural reforms. As ways of thinking, values and consumption habits change, every company will face the challenge of renewing its own business logic in order to grasp the opportunities provided by circular economy. Although digitalisation and servitisation emphasise virtual solutions, there will also be a need for energy-efficient, low-emission and agile production processes, manufacturing industry and logistics solutions.

In addition to substances and materials, economic and intangible value will circulate and even increase. Value will be increased by closing material cycles, thus minimising waste. In addition, the value of materials and products will be maintained, while new value is created through technology and services. At the same time, overall resource efficiency will be developed in all parts of the cycle. The system will be reviewed holistically (lifecycle thinking) and the societal and environmental impacts will be evaluated across the whole value chain.



The circular economy will create new business while disrupting current business models, networks and competencies. We can prepare for this by understanding the forthcoming change in the business environment, recognising the opportunities and seeking new ways of creating value alongside other actors. The circular economy requires change at all company levels – in their strategies, business models and processes. In a circular economy, value will be created within ecosystems. New partnerships will be needed for the creation and distribution of value. In addition, new operating models for partnerships in areas such as the sharing and use of data will be needed in ecosystems.

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## Instead of a single company, ecosystems close the loop.

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### Growth via circular economy services

Two thirds of Finland's GDP now consists of services. This figure will be even higher in the circular economy of the future. Instead of selling ownership, access and right to use will be sold, and product lifecycles will be lengthened through upgrades, repairs and remanufacturing. Value will be created by the more efficient distribution and optimisation of resources. When wisely planned and implemented, this will lead to major reductions in the environmental load. Circular economy will also create a demand for completely new services, including product and material collection and logistics, and platforms bringing together users and service providers. Growth and employment will be brought to Europe by expanding the service sector.

Servitisation and digitalisation will support circular economy concepts along the entire production and product lifecycle. Under the service model, the user will shift towards paying for the right to use, which will motivate the service provider and service user to jointly optimise resource use. The transition from product seller to service provider will require a change in company cultures, processes and business models. Process adjustment and a change in mindset will also be needed on the buyer's side. A successful service model will create a closer collaboration relationship from which all parties benefit. In some sectors such as the car industry, leasing and rental agreements are already everyday occurrences, whereas they are only just emerging in other areas such as in the chemicals industry.

Through services, broader ecosystems can be built through which both companies and consumers can be offered more comprehensive solutions. The circular economy will be both global and local. Services will be brought closer to consumers and the routes along which they travel. Internet of Things (IoT) solutions will enable the smooth use of such services.

### Skilled users of information will succeed

Digitalisation is boosting and accelerating the circular economy. IoT solutions are being used to track raw materials, products and equipment, optimise their utilisation rate and monitor their condition. This is increasing the interest of companies in switching to services based on improved opportunities to gather data across product lifecycles. Companies in possession of data and competencies to process it will be able to develop their own operations and discover new business opportunities. Various service platforms are connecting service producers with users. Examples include sharing economy platforms through which attractive and value-adding consumer services, such as car sharing and accommodation exchange or rental services, are being created. Correspondingly, digital platforms are creating new business opportunities in inter-company operations for skilled combiners of data, but success requires openness of boundary resources.

The rapidly developing blockchain technology is creating cost-effective, global and secure solutions for payment, sharing, making contracts and the optimisation of resource use both between companies and consumers, which is helping to create new business models for the circular economy.

### Material flows circulate and transform

In the circular economy, materials will not end up as waste or side streams. Instead, they will circulate within and between different supply chains, and they will often be re-formed. Sustainably and efficiently generated raw materials from waste and side streams require new technological solutions. In the circular economy, the focus will be on material flow management, involving the close monitoring and traceability of material flows and new logistics solutions, creating new business opportunities in the sector and new services for consumers.

In addition, conducting public service procurement according to the principles of circular economy opens new business opportunities for new and existing companies. These will include new material

and energy efficient solutions in the production, use and maintenance of traffic infrastructure, public buildings, waste management and the water supply.

Logistics will grow in importance as companies and consumers switch from ownership to the use of services. How can I arrange easy and cheap access and return of the car, steam cleaner or curtains I booked? Economical and ecological supply chain management will be a fundamental requirement of a well-functioning circular economy.

## Comprehensive solutions meeting consumer needs

None of us want poorly functioning domestic appliances or low-quality textiles in our homes. Many of us would love having easy access to door-to-door transport services based on a single payment and ticket. A handy solution for confirming that food is edible and for avoiding unnecessary waste would also be useful.

Solutions for all of these needs, which promote the circular economy and provide consumers with added value, either exist or are being developed. Attractive consumer services which make everyday life easier have already appeared and are continuously emerging via the sharing economy.

Through our choices and the messages we send as consumers, we have a huge opportunity to shape the kinds of products and services created. Circular economy presents consumers with an unprecedented opportunity, which is about smarter solutions for different needs, not settling for less.

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## Pilots are vehicles for learning and drivers of new thinking

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The transition from ownership to purchasing the right of use will require a change in mindset and practices. For this reason, it is important that consumers and users are actively involved in planning, implementing and piloting services. Promoting an experimental culture is crucial to the development of a circular economy. New business models and technologies can be rapidly tested and tangible results obtained on the basis of trials and large-scale pilots. Examples of this include hackathons arranged by companies and other organisations for the development of ideas. In addition, concrete trial platforms are needed to support process and product development of the companies. VTT's Bioruukki, in which biomass- and side- and waste stream processes are being developed to accelerate the commercialisation of bioeconomy innovations, is a good example of this.

Trials also help to ensure the sustainability of new business models and technologies. A new, resource-saving solution will not necessarily reduce the environmental load, since it could also generate the need for greater energy consumption, longer transportations or even new chemicals. Environmental impacts are evaluated alongside economic and social impacts, using lifecycle-based methods developed for this purpose, such as lifecycle assessment or the carbon and water footprint. With these, overall impacts of a circular economy solution can be calculated.

## New use of waste, new products from side streams

In the circular economy, discarded goods and materials, i.e. waste, will be returned to the cycle after use and given a second lease of life through technological innovations, perhaps in a new form. In addition, side streams from production chains and cycles will be refined into high-value products. Resource efficiency and sufficiency are key issues of circular economy, involving a transition from a sub-optimal state to comprehensive operating models that take into account the entire lifecycle. Novel business models, the productisation of waste and side streams and the creation of markets will be prerequisites for effective recovery of resources.

## Circular economy starts from design

Circular economy will require user-centered service and product design, from raw materials to service concepts and from use to disposal. Consumption of resources during the use of products and services will be reduced by energy-efficient solutions and increasing the utilisation rate. Products should also have the longest possible maintenance of value through repair, upgrading, re-use and remanufacturing. Products will be recycled as efficiently and safely as possible at the end of the lifecycle. Overall, this concept will lead to a minimal environmental load.

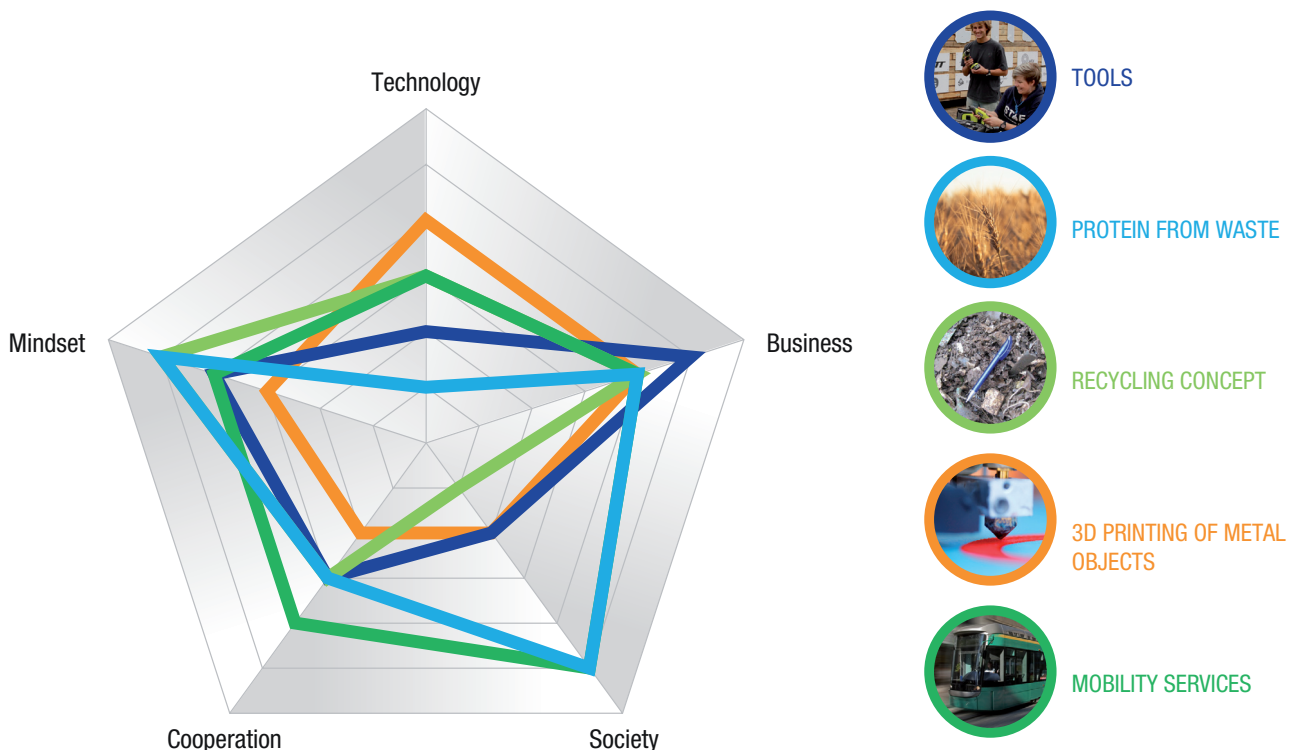
Data analytics, simulation and modelling will create new opportunities for e.g. monitoring, preventive maintenance and optimisation throughout the value chain, as well as for the evaluation of user needs and approval. Traditional operating models can therefore be disrupted on the basis of better and proactive understanding of service users.

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## Circular economy is a rough diamond with huge business potential.

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Changes of many kinds and levels will be required on the journey to circular economy. The solutions we propose highlight the need for technological and business development, the transformation of society and mindsets, and closer cooperation.



## Case 1: 24/7 tool rental and services easing the daily lives of consumers

We all have tools in our cupboards that we hardly ever use. They take up valuable storage space in our homes and are not always as high quality as we would like. The Liiteri.net pilot was designed to meet these and other everyday challenges; this service provides higher quality tools and cleaning equipment free of maintenance needs, the risk of making the wrong purchase, or breakage. Tools can be picked up 24/7 or ordered for home delivery from the Liiteri service point in the Helsinki Teurastamo centre.

The Liiteri pilot is providing concrete data on consumer behaviour, the public's reception of the service and the level of interest in it. Answers are also being sought to how and what scope of solutions can be offered to consumers for renovation and building, or to fulfil more general everyday needs.



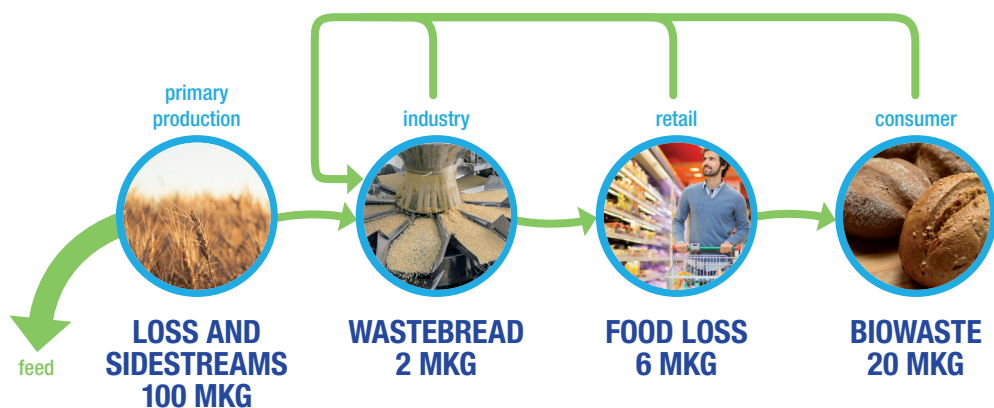
Rental models always save on material resources: potentially a third or even more, depending on the collection method and distance. The more efficient the logistics chain between the rental service and the customer, the greater are the savings achieved. In addition to such savings, shifting to equipment rental has positive economic and employment impacts due to growth in the service sector. In Finland around EUR 2.5 billion is spent on cars each year, and over a billion is spent on other consumer durables. Most of these goods are imports. If even some of these were transferred to the service business, it would have a major employment effect in Finland.

*The circular economy pilot, Liiteri (TownHall 24), is being implemented by IT start-up CoReorient in cooperation with the AARRE project coordinated by VTT, which also involves the Finnish Environment Institute (SYKE) and the University of Helsinki. K-Rauta, the Helsinki Region Environmental Services Authority HSY, the Federation of Finnish Technology Industries, SER-kierrätys, the City of Espoo and Purjebägit Ltd, Kierrätysverkko Ltd, Metrosuutarit.fi, Pyörähuoltoovelle.fi and Kauppa-halli24.fi are also involved.*

## Case 2. Protein from bread chain waste for over a hundred thousand Finns

Each year, around 30 million kilograms of Finnish grain, intermediate and final products, are wasted at different points of the bread chain, particularly during consumption. So much valuable vegetable protein is wasted at the same time that it would satisfy the protein requirements of a mid-sized Finnish town for an entire year.

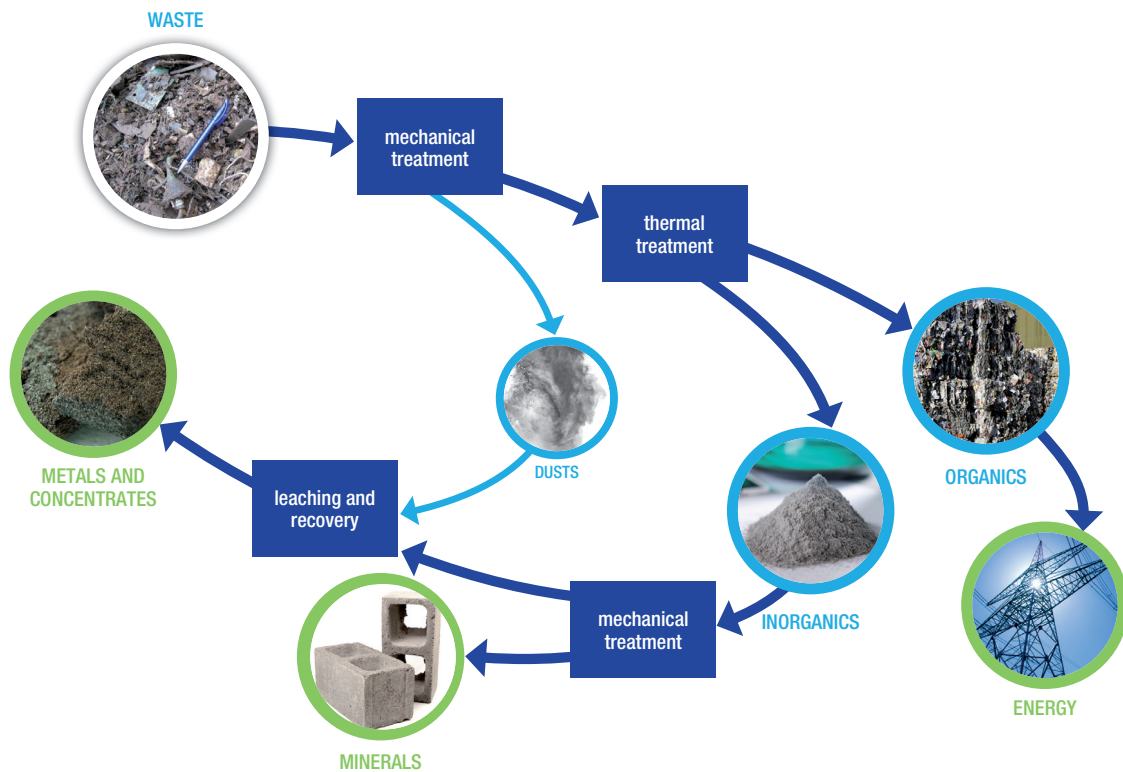
At the same time as around 150 million kilograms of grain and grain products, including bread, are wasted each year in production, industry, shops and particularly in households, Finland imports 200 million kilograms of soy. Most of this is used as feed. Should we consider replacing imported feed-grade soy with what we now waste within the cereal and bread chains? This would create new business and increase our self-sufficiency in protein. If this waste were to be recycled for human consumption, its value would increase to tens of millions of euros.



### Case 3. A new recycling concept makes the most of waste

Waste has become a globally traded commodity. Large quantities of valuable materials are still being lost in waste recycling and processing chains, and up to half of the materials in the chain may end up in landfills. Traditional mechanical recycling processes are not optimised for the recycling of increasingly complex products. By adopting recycling concepts based on integrated technologies, we could reduce material waste and meet stricter recycling targets.

For example, electronics recycling mainly focuses on the recovery of basic and precious metals such as gold, whereas other valuable materials and rejects from the processing chain itself remain unexploited. New integrated technologies and recycling concepts will improve the efficiency of metal recycling, thereby enabling the recovery of valuable materials. This would replace not only virgin minerals, but also fossil raw materials.



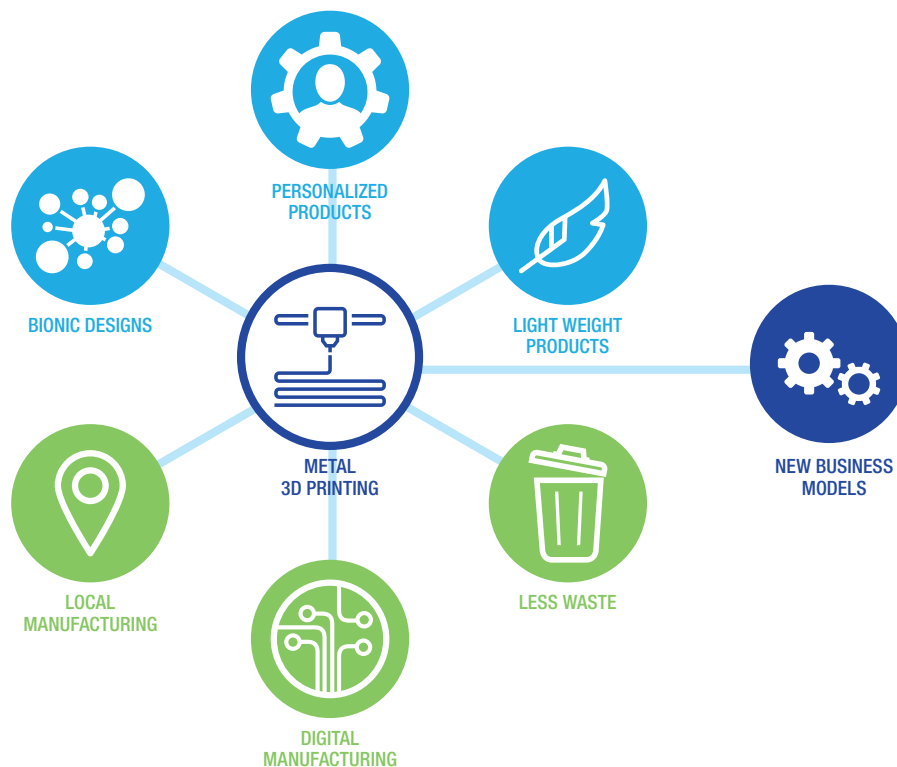


## Case 4. Personalised and material-efficient spare parts via 3D printing

A digital service for 3D-printed metal spare parts and repairs reflects the on-going transformation in design and repair & maintenance operations. In these lines of business, single items often travel long distances with long waiting times, or suppliers are committed to keeping buffer stocks of parts just in case. Printing is an additive manufacturing technique which is creating wholly new opportunities in the design of complex structures, material selection, making products lighter, new product functions and new opportunities in the use and repair of products. A digitally transferred product file and printing close to the user would move part of the logistics online, and enable the easy creation of channels inside objects and thus a lighter end product. For example, channels have traditionally had to be bored into a metal object that needs internal cavities or chambers.

In addition to providing new design possibilities, digital spare parts – which are sold partly as a service rather than simply as a product – involve local manufacturing units. This keeps manufacturing expertise close to users, over more dispersed areas. Digitalisation, expertise in 3D design, the possibility of novel customisation techniques and local manufacturing are highlighted by this transformation. At the same time, the operational reliability, service life and upgradability of repaired products are improved in line with circular economy principles.

What opportunities does this offer Finland? We could invest in our own 3D design expertise, in which case product protection (to impede copying) and digital security would take centre stage. On the other hand, when we need products close to the customer in Finland, we could upgrade local metal production with 3D printing capabilities.



## Case 5. Adaptive mobility services

The mobility services and automation in transportation are expected to increase the degree of utilisation of vehicles, and to promote the use of combined modes of mobility. This will reduce the consumption of resources related to traffic. However, the positive effects of these new solutions can only be achieved if they are designed and implemented in such a manner that their user numbers grow markedly.

Customer-focused design and technology expertise will hold the key to whether a solution can compete with private cars in terms of price and flexibility. If sensors are used to detect the movement of people within, say, shopping centres and recreational areas, and various data streams – such as the weather, events, traffic volumes and availability of shared vehicles – are combined to forecast the need for vehicles, customers can be provided with smooth transfer from one place to another without their own car. Technologies enabling the detection of flows of people and the control of robot cars include sensor technologies such as LIDAR, radar, machine vision and hyperspectral imaging.

The number of people travelling together in each vehicle is expected to increase slightly within the context of mobility services. Estimates of the reduction in the number of vehicles among mobility service users vary greatly: from 5 to 90 percent. Well-functioning mobility services would also shift consumption from the ownership of imported cars and private motoring towards the use of local services, which would have positive effects on local employment.



# Cut your own diamond and join VTT on a journey towards circular economy!

## Summary

- Finland is making the transition to circular economy on the basis of new business and technology innovations.
- Grasping the opportunities of circular economy will require systemic transformation in society, as well as new kinds of business competencies, new technological solutions, a change in mindsets and structural reforms.
- In circular economy, value is created and distributed within ecosystems. In addition, new operating models for collaboration within the ecosystem, in areas such as the sharing and utilisation of information, are needed.
- The environmental impacts of circular economy concepts must be evaluated and optimised for all stages of the value chain (lifecycle thinking) already at the design stage.
- Via circular economy, an increasing proportion of Finland's GDP will be based on services. Service businesses will bring employment to Finland. Circular economy will create a demand for wholly new services, such as product and materials collection and logistics, product after-markets, and platforms that bring together users and service providers.
- Data volumes will grow further through digitalisation: Those with data will benefit in terms of the development of their own businesses and may find new business opportunities. Blockchain technology is opening up new business opportunities.
- Circular economy presents consumers with an unprecedented opportunity: this is about offering smarter solutions for different needs, not settling for less.
- Pilots will be means for learning, and drivers of new ideas during the transition to circular economy.
- New technologies and practices in primary production, the food industry, retail and consumption will enable the reduction of food waste. They will improve material efficiency and create business opportunities for domestic industry.
- Electronics can be integrated in more and more products. This is creating new opportunities for monitoring and optimising material flows. On the other hand, new breeds of electronic products should also be taken into account in recycling processes – this will increase the need for new combined technologies and create new business opportunities.
- 3D printing will enable the emergence of new businesses based on lower material consumption in the manufacture of machine and equipment parts. A new type of metal processing will appear in Finland at the same time.
- We can increase resource efficiency in mobility and logistics by designing services that based on understanding the everyday lives of consumers and by leveraging emerging technologies.



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