# Leveraging Artificial Intelligence to advance Circular Economy

A COLLABORATIVE WHITE PAPER

Produced by:
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# Contents

# Key Messages

1. Digitalisation has a large role to play in the transition to Circular Economics. However, this relationship has not been fully recognized by the majority of organisations as yet
2. Businesses have been applying AI solutions with positive benefits for resource and material management, but often miss the opportunity to identify them as 'circular' in nature
3. The financial & environmental benefits of Circular Economics can be realised by utilising new and already available AI-driven solutions, provided that they are integrated into the overall innovation or digitalisation strategy
4. AI has the potential to create significant value globally – current estimates suggest an effect of 2.2 trillion EUR by 2030, in food and consumer electronics alone
5. Governments and international institutions have often struggled to provide solid guidance on transitions towards circular economics driven by digitalisation
6. Significant EU and private funding could be available for businesses that can substantiate the AI / circular relationship. For example, the European Investment Bank has provided EUR 2.1 billion in co-financing circular projects
7. Circular business models utilising AI solutions present an opportunity to mitigate structural business risks for companies prone to the potential effect of climate change and resource scarcity in their production


# EXECUTIVE SUMMARY

## Background

The Circular Economy conversation has taken off in the last few years and so have discussions around technology having a key role in the transition towards circular strategies.  However, organisations find it challenging to link their digital efforts to sustainability and circularity benefits.

This report aims to increase understanding of the relationship between technology – specifically AI, and circularity. It is written jointly by MissionC and Fountech.ai, combining our Circular Economy (CE) and Artificial Intelligence (AI) expertise specialities. Our goal is to highlight how AI can be used to drive CE solutions and to provide an initial overview of specific AI instances that can be applied across contemporary industries.

## The inevitable need for change

We live in times where over-consumption based on the linear economy principles of 'make – take – dispose' rules the world. Our current production and consumption patterns lead to destruction of the environment and climate crisis. This situation is not sustainable from a socio-economic perspective.

To be able to reverse the negative effects of climate change, we have to rethink the way the global economy operates. According to research[1], transition to renewable energy and energy efficiency has the potential to cut around 55% of existing harmful emissions. The remaining 45% is attributable to manufacturing of products that we use every day and related virgin material extraction: such as food, cars, clothes and so on. Circular Economy can fill the gap in emissions reduction by redesigning the way we make and use products.

Highlighted AI modules for circular Innovation

- Data clustering
- Timeseries analysis
- Outlier detection
- Computer vision & object detection
- Chat bots
- Entity recognition
- Summarisation
- Text classification

Overview of discussed applications

- Demand & supply management of goods & resources
- Production, maintenance & analytics
- Resource & waste monitoring
- Agriculture & food production
- E-healthcare
- Regulation, reporting & risk management

However, the transition to more sustainable business is no longer just inevitable from an environmental point of view, it has become essential to maintain economic viability and to comply with ever-strengthening regulation. With only 9% of the world economy being circular[2] and given the expanding Circular Economy and sustainability targets of national governments, there is a major opportunity for organisations to adjust their business models and create a tangible long-term competitive advantage.

It is estimated that the transition towards Circular Economics provides an opportunity worth around 1.8 trillion EUR annually in Europe alone[3].

Business benefits are illustrated by the research of the WBCSD and BCG[4], which found that 97% of respondents indicated that Circular Economics drove innovation and made companies more efficient and competitive. 51% stated that circular activities already add to company profits. We believe that transitioning to circular-centric business does not have to be 'rocket science'. Utilisation of available AI-based solutions, substantiating the relationship between digital and circular, and integrating sustainability into innovation & growth strategies, can be relatively easy first steps for companies to take.

## Major companies are already benefiting from circular initiatives

Process optimisation, smarter use & reuse of materials, improved waste management, providing access to products instead of ownership and others are all examples of steps that organisations have been taking to become circular. Technology is one of the key drivers of this shift and AI solutions coupled with Big Data represent an untapped potential to amplify the benefits of Circular Economics even further.

The steps that some major companies are taking support the statement that the transition to Circular Economics is possible, inevitable, and indeed makes good financial sense. One of the examples of a global firm combining several circular practices, products and models into their business is Philips[5]; with a target to generate 15% of its total revenues from circular products and services by 2020. In 2018, they already generated 12% (over 2 billion EUR) in revenue from circular propositions.

## Approach of the White Paper

Our overall ambition is to move beyond mere conceptual thinking and to empower organizations with pragmatic AI solutions for CE, thus creating business benefits. Organizations now have the power to connect technology to CE solutions by employing various features of AI in order to increase operational efficiency, lower costs, reduce risk and engage customers. At the same time, they can save environmental resources through the **identified AI modules for circular innovation**. Based on our joint expertise and research, these key **AI applications** were identified.

## Key recommendations

**While developing solutions which enable AI to accelerate the transition to Circular Economics, organisations can take action with these strategies.**

1. Businesses can embed Circular Economic targets into their strategies and utilize the opportunity to use digital transformation to reach them;
2. The investment community can stimulate the transition to Circular Economics through increased mobilisation of capital towards Tech/AI-businesses;
3. Governments can help by creating regulations and policies enabling and speeding up the implementation of new technology and circular business models;
4. Public – private collaboration can be intensified to achieve national Circular Economic targets, through strengthening the ecosystem for innovation.

## Call for action

**How is your organization engaging AI to realize the opportunities that Circular Economics offers? Get in touch with us to explore how to turn ideas into practical solutions to futureproof your strategy.**

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# MOVING FROM LINEAR TO CIRCULAR ECONOMY

The global economy is largely dependent on material resources. Given current consumption trends, we might be unable to sustain the demand of the world population in the near future, a number which is rapidly increasing.

It has been recognized that overconsumption based on the linear economy principles of 'make – take – dispose' is no longer sustainable. The current economic system leads to destroying the environment and presents a threat to business continuity.

## A necessary transition to Circular Economy

During the Paris 2015 United Nations summit[6] (COP21), countries agreed to limit any further temperature rise below 2°C by 2030. In order to do so, certain emissions linked to industrial production processes and waste must be radically decreased. To accomplish this, we have to rethink the overall economic model.

The Ellen MacArthur Foundation, a leading think tank on Circular Economy, defines CE as an "industrial system that is restorative or regenerative by intention and design"[7]. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals and aims for the elimination of waste through the smart design of materials, products, systems and business models.

Unlike in the linear economy, where value is created by the volumes of product being sold to customers using new inputs and disposing them as waste at the end of their lifecycle, in circular economy, the value is created from within. This is done by maximizing the use of all the input materials and resources, thus ensuring that their lifecycle is extended and no resources are wasted.

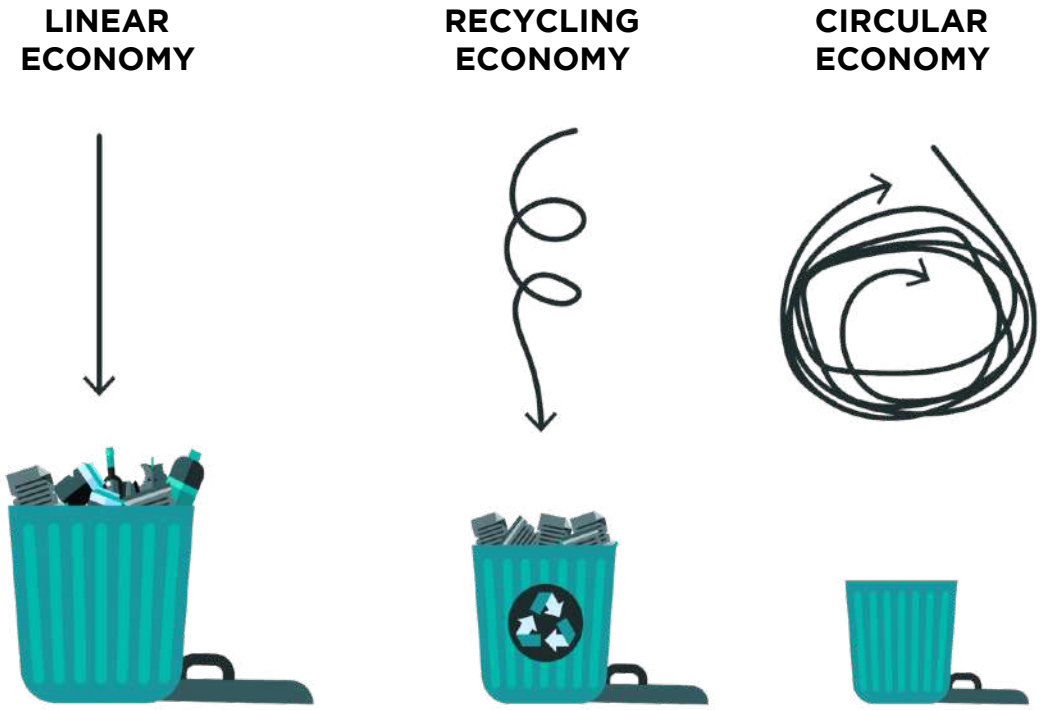


***Illustration adapted from 'Circular Flanders'.***
*Linear economy principles are based on take-make-dispose which leads to inefficient use and waste of resources. A recycling economy helps to reduce waste via reusing certain materials at the end of their use. Circular Economy principles aim to minimize waste by introducing the new business models based on a modular design, access to products over ownership, reusable materials and better usability of all the materials within their lifecycle.*

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A primary focus of the Circular Economy is not only to minimize waste, but also to reduce dependency on continuously scarce virgin resources, decrease the negative environmental impact linked to CO2 emissions and utilize existing economic products effectively.

The transition towards Circular Economics may also revolutionize overall consumption. It requires a new way of thinking in regards to resources, a new way of looking at existing products, rethinking designs in an innovative way for enhancing longevity and creating new relationships with customers and markets.  We highlight some of these actions below.

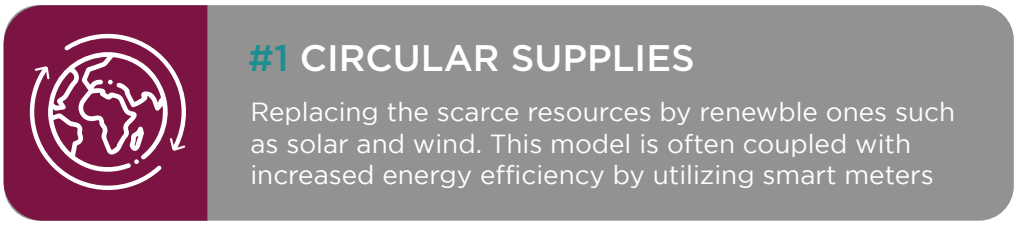
More efficient use of materials, including increasing their use intensity, product lifetime extension, recovering materials and reusing them as much as possible before the end of their lifecycle, can have a significant impact on reducing emissions. Physical waste that we currently produce is not only a waste of resources, it is also a financial waste, because we are processing around 11 billion tons of needless waste per year[8].

A Global Circularity Gap report re-launched during the Davos World Economic Forum of 2019, revealed that the world's economy is only 9% circular. In order to close the material loop to create a circular ecosystem, technological involvement is essential. From sensors collecting data, through use of like blockchain and AI, digital solutions not only facilitate monitoring of resources and coordinate their more efficient use, but also connect all partners in a circular ecosystem.

## Circular transformation driven by innovative business models

Since the resources on our planet are limited, transition towards circular economics is not only desirable, but must be inevitable. We have to make the move from the linear model and adapt new business models enabling Circular Economics.

**Typically, the majority of Circular Economic opportunities can be linked to these five business models:**



### #1 CIRCULAR SUPPLIES

Replacing the scarce resources by renewble ones such as solar and wind. This model is often coupled with increased energy efficiency by utilizing smart meters

### #2 RESOURCE RECOVERY

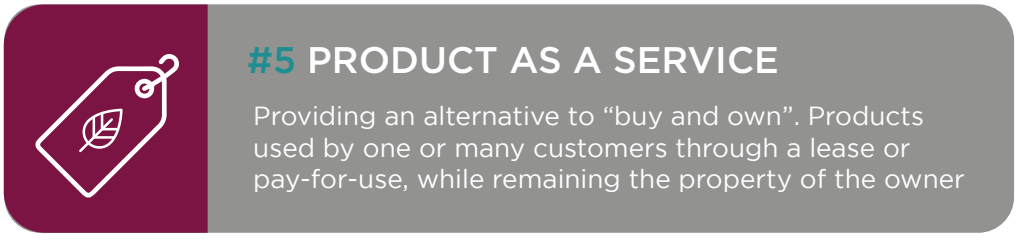
Enabling organisations to innovate and increrase resource efficiency through reuse and re/up-cycling of existing materials. Products often sold at premium

### #3 PRODUCT LIFE EXTENSION

Extending product life cycle through innovative design, eliminating material waste & enabling repair. Highlighting quality that will last and is worth repairing over quantity

### #4 SHARING PLATFORMS

More efficient use of the existing products and services offerred to multiple customers. Sharing platforms also promote collaboration in the ecosystem



### #5 PRODUCT AS A SERVICE

Providing an alternative to “buy and own”. Products used by one or many customers through a lease or pay-for-use, while remaining the property of the owner

It is important to state that organisations can transition towards circular business models gradually, often exploring and combining several of these – for example, offering products from more sustainable materials (circular supplies and resource recovery) through leasing constructions rather than selling them directly (product as a service). It is also important to acknowledge the value of a circular ecosystem. Building an ecosystem of businesses, service providers, including financial institutions, and available infrastructure, powered by technological advancements such as Artificial Intelligence (AI) is an essential cornerstone of CE. Therefore, collaboration among all the parties is key.

Circular Economy goes far beyond just a macro-economic framework. The efforts of global businesses prove that it makes sense at company level as well. Philips, one of the world leaders in the circular transition, has set a target to generate 15% of the total revenues from circular products and services by 2020. In 2018, they already generated over 2 billion EUR from circular propositions - 12% of their revenues.
And there is more. Adidas, Lego, IKEA, Akzo Nobel, DSM-Niaga, ING Bank and others are just a few examples of global players that are adopting circular business practices in setting targets to futureproof their businesses.

## Governments are setting ambitious CE targets

The challenge of using circular economic principles to alleviate climate change has been central to European and worldwide agendas for the past few years, in fact, various countries are further strengthening their commitments.

Europe's ambitious plan of "closing the loop" on product lifecycles was set in motion at the end of 2015 and has been developing ever since. As part of its continuous effort and to implement the ambitious Circular Economy Action Plan, in January 2018 the European Commission adopted a new set of measures:

- By 2030, all plastics packaging should be recyclable;
- Published a directive on the inter-relationship between chemical, product and waste legislation that assesses how these factors co-synergise;
- Set up a monitoring Framework on progress towards a circular economy at EU and national level. It is composed of a set of ten key indicators which cover each phase – i.e. production, consumption, waste management and secondary raw materials – as well as economic aspects – investments and jobs - and innovation;
- A report on critical raw materials and the CE that highlights the potential to make the use of such materials within in our practices to be more circular.

In 2016, Finland was the first country to publish a national roadmap to become circular by 2025. This roadmap has been further updated earlier this year to include further CE measures. The country has a strategy to become competitive and to ensure wellbeing for its citizens through offering services and long-lasting recyclable products. This is to be enabled through digital solutions rather than solely selling products according to the traditional 'take-make-dispose' linear model.

## Funding is available to drive Circular Economy businesses

Governments are not only setting CE targets, but are also allocating significant financial resources to support these transitions. The Dutch government has announced an additional contribution of 80 million EUR[9] to promote CE in 2019 and 2020. Across the EU, new types of loans are being set up to address the specific financing needs of circular businesses, incorporating a lower interest rate and risk sharing. This type of financing is particularly interesting for entrepreneurs in their early stages and could enable them to climb up from the notorious 'death valley' phase before they are generating enough revenues to be attractive to venture capital or private equity financing.

By way of example, the European Commission has allocated funds of over 650 million EUR under 'Horizon 2020' to support circular initiatives and 5.5 billion EUR under their structural funds. In the investment framework for 2014-2020, there is significant funding for waste management, with funds in total reaching 150 billion EUR. The European Commission has also been working on a new financing package beyond 2020; the European Investment Bank (EIB) can also play the role of a partner for circular investments and has provided 2.1 billion EUR in co-financing for circular projects over the last five years.

In October 2019, the world's largest asset management firm BlackRock has launched together with Ellen MacArthur Foundation a new circular economy fund, starting with 20 million USD[10]. With increasing interest in impact investments and efforts to account for climate risks in portfolios, circular business presents a relatively new type of opportunity for private investors as well. A lot is being discussed in order to increase funding into circular businesses. Technological companies – such as AI based, typically have the highest potential for scalability, thus the highest chances to acquire traditional private capital funding.

# DIGITAL, AI AND CIRCULAR JOINGING FORCES

## Diving into the untapped tech potential

Digitalisation, leveraging digital information to improve business processes[11], is often considered as one of the most critical drivers of CE.  Yet, companies have been struggling to substantiate this relationship, by integrating these elements into a solid strategy, setting and reaching achievable targets and performance measurements. With governments and businesses setting specific targets on CE goals, for example, the Netherlands aims to achieve a 100% circular economy by 2050[12], technology (as we will see with examples presented in this White Paper) is one of the most potent enablers of this process.

## AI at a glance

Artificial Intelligence (AI) is one of the key drivers of the Fourth Industrial Revolution. It can be loosely defined as software mimicking aspects of human behaviour. Amongst others, this includes learning, reasoning, problem solving, knowledge representation, perception, motion, social intelligence and creativity.

To a great extent, AI achieves this by employing algorithms that find patterns and extract useful information from (large amounts of) data. Thanks to recent computational advances, today we can meet the operational requirements to develop such software.

There are a few approaches for mimicking human intelligence, and at the core of those is machine learning. Machine learning methods, unlike conventional algorithms, are dynamic and can adjust in response to the data to which they are they are exposed and hence applicable to many domains.

**Machine learning is a broad field, but algorithms are often grouped into three main categories:**

1. Supervised learning
2. Unsupervised learning
3. Reinforcement learning

In supervised learning, the algorithm learns by exploiting the ground truth. That is, input datasets are associated with a known outcome and the algorithm learns by example, the importance attributed to each input to correctly predict the outcome.
On the other hand, for unsupervised methods the goal is to automatically discover the inherited structure of the data without any prior knowledge. Often, the result is the creation of clusters that group data with similar properties together. Lastly in reinforcement learning, the model learns based on a reward system, where it gets rewarded when making right decisions, from a set of allowed actions under particular circumstances, and penalized when making wrong ones. Rather than knowing a ground truth, the system learns by itself courtesy of trying to maximise the amount of reward points.
Another important category is natural language processing (NLP). These methods generally fall under supervised learning but because they deal with the understanding and usage of language by computers, they are often referred to separately. NLP is further subdivided into two other categories, Natural Language Understanding (NLU) which deals with deriving human understandable context/meaning from digital text and Natural Language Generation (NLG) which deals with text composition into a human understandable form.

Depending on the desired outcome algorithms that comprise the above categories are used to train models to perform the necessary functionality. In real world applications, more than one AI model is developed to carry out the expected functionality. The skilled developer is able to recognise which of the algorithms can be used, and interfaced appropriately, to create such solutions.

## AI and digitalisation driving circularity

The transition towards circular economy may be one of the biggest opportunities for the global economy as a whole. AI has a large role to play, and the various AI applications can help unlock a value of 127 billion USD per year by 2030 in food alone[13].

Attributing companies' digitalization efforts to focus towards CE goals is essential. For example, on the business and product development side, products that are a result of both technological and circular principles enhance innovation and can create significant economic opportunities. This is why at MissionC and Fountech we believe CE and AI go hand in hand;  we can help you navigate the new world of this industrial and economic era. In the following sections, we provide examples where AI can be used to enable organisations to adopt circular practices.

# AI MODULES APPLICABLE IN CIRCULAR INNOVATION

As mentioned earlier, AI is a broad term covering many principles and technologies. This section introduces algorithms that can be developed and applied in Circular Economics across various industries. In many cases a 'mix-and-match' approach can address potential needs.

## Clustering

A single data entry can be described using many quantifiable attributes. In technical terms we call the number of attributes features or dimensions. For example, in geographical terms a city can be uniquely described using two attributes, longitude and latitude. Colours can be described with three attributes, their relative composition of red, green and blue. Clustering algorithms take as input the features/attributes and aim to create groups of the various datapoints.

The applicability of clustering algorithms can be found when creating digital sharing platforms. Relative distances between those that own specialised equipment and those that want to use it can be quantified in this manner and help bring stakeholders together. For example, shared platforms can be used by local authorities using shared resources or by hardware companies renting out equipment.

## Timeseries analysis

Timeseries describe how a variable evolves over time. For example, resource consumption in a building can be described as the amount of water spent during the day. Timeseries analysis can be used to detect any repeating patterns or to predict future events. Methods include Fourier transforms, spectrograms, lines of best fit and extrapolation and even deep learning models like Long Short-Term Memory (LSTM). Applications can be found in the preventative maintenance of electronic equipment by monitoring device health, urban resource monitoring such as water and even efficient food production where consumption can be monitored to predict future demand.

## Outlier detection

For equipment, operability occurs within a certain set of values. For humans, a healthy state is usually inferred by comparing metrics such as heart-rate or glucose to those that we know are considered normal. Outlier detection algorithms take in data values and define normality by looking at statistical measures such as mean, standard-deviation, kurtosis (the sharpness of the peak of a frequency-distribution curve) and many more. This data-driven approach can define "normal operating conditions", enabling algorithms to detect when values go beyond such range.

Outlier detection is applicable in product maintenance, urban resource monitoring (e.g. average water consumption of a given household), healthcare and many more. In general, where numbers can be used to describe ranges, outlier detection can help in addressing deviation from normality.

## Computer Vision, object detection (and classification)

Image analysis is when algorithms are trained to detect whether a particular object is found within an image or not. Invariably image analysis is a classification problem, as the algorithms learn to classify whether an object is present in an image, and if applicable, where in the image such an object is found.  There exist many classification algorithms, each applicable under specific scenarios, examples including logistic regression, Support Vector Machines (SVMs) and (deep) Neural Networks (NN). Computer vision can be applicable in urban waste management (e.g. detecting when waste bins are full), healthcare (detecting bone fractures in X-rays), recycling (sorting objects into those that can be recycled or reused and those that cannot) and food production (detecting the colour and size of mature crop).

## Chat bots

Chat bots, or more formally conversational agents, can be used to engage with humans. Ultimately chatbots can be used to understand what someone wants and reply back to them accordingly with correct information. NLP algorithms are used to derive meaning from text. Various algorithms exist whose objective is to quantify words in text to be able to compute, or derive, meaning from it.

Chat bots can be used in education, where for example users can ask routine questions and receive replies that are consistent with company policy, or in healthcare for self-diagnosis and referral of non-urgent situations. Another application includes use in client contact, account management, etc.

## Entity recognition

Entity recognition (ER), an NLU algorithm, takes as input a piece of digital text and produces as output structured data in the form of annotated entities found within the text. For example, in the sentence "John has been diagnosed with mild headache and was prescribed paracetamol".
A possible output is "Person: John, Name: John, diagnosis: headache, medicine: paracetamol".

ER can be used in healthcare to quickly create or review patient histories. ER is also useful in any industry that deals with parsing texts such as the regulatory or financial services industries.

## Summarisation

Summarisation is also an NLU algorithm. Summarisation algorithms take as input large pieces of text and return a summary of the contained information. Approaches usually involve ascribing an importance value to each word, for example via its frequency in a given text. Then each word's importance contributes to an overall sentence importance, enabling the creation of summaries.

Summarisation can be useful to any industry that deals with large bodies of text such as healthcare (e.g. patient history reports), education and the governmental sector (e.g. large volumes of educational material converted to summaries).

## Text classification with Natural Language Understanding

Natural Language Understanding (NLU) algorithms convert words into quantifiable objects. Once in a quantitative format the words can be processed with classification algorithms.

One example, perhaps relevant to governmental authorities or the healthcare industry, is to classify text into various subjects/topics. This allows to easily index existing and new documents by processing the contents of the document with NLU methods.

Another example, more relevant to the financial and regulatory industry, is to assess the risk of customers based on reports that gather data that describe their activity. Keywords such as money-laundering, imprisonment etc. can describe someone with a high-risk profile. NLU algorithms can be used to parse the text and automatically classify the risk of a potential customer.

# THE CROSS-INDUSTRY APPLICATION OF AI TO ACHIEVE CE BENEFITS

We have looked into different aspects of AI and how it is being implemented to boost circular business models in different industries. Below is an initial overview of identified AI innovations accelerating CE transition – we have selected these examples to demonstrate the cases from our practice, however, we acknowledge there are more examples already in place across industry sectors and geographic locations.

- Demand & supply management of goods & resources
- Production, maintenance & analytics
- Resource & waste monitoring
- Agriculture & food production
- E - healthcare
- Regulation, reporting & risk management
- Education & engagement tools

## Demand and supply management of goods & resources

Modern lifestyles have us all accustomed to assume that ownership of products, and the constantly growing desire to keep up with the trends in product development, is the only way to live our daily lives. Naturally, this mindset drives the ever growing need for more resources and creates large amounts of waste once we decide to dispose of our product and replace it with a new one. Very often such products are not fully utilized to their potential. The fashion industry is a notorious example: The average person buys 60% more items of clothing and keeps them for about half as long as in 2000[14].

Every second, an equivalent of a truck full of textiles is either burned or ends up in landfill sites. CE can utilise such clothing products much more efficiently, keeping raw materials in circulation through repair, reuse, repurposing or recycling. Simply having access to products as opposed to their actual ownership would result in dematerialization, less carbon dioxide emissions from resource extraction and production, as well as less waste in landfills.

An efficient and functional way of maximizing product usage is via sharing with others. To have access to it rather than owning it. For example, individuals can choose to rent-out their car or bike to others when not using it, share electronic devices, or even heavier equipment such as gardening or building machinery.  In this case, people could simply rent out clothes. It's already commonplace with dinner suits, wedding and formal wear, but there's no reason why more commonplace garments couldn't be rented on that basis.  Clearly no-one is going to want to rent a pair of underpants, but if you need a pair of navy blue chinos with a pair of brown brogues for just one particular occasion, that's where the sourcing capabilities of AI and the internet can come into play.
AI can enable seamless transfer and lending via an AI powered platform, connecting the owners of products and materials with those who want to use them. The AI solution can take into account many factors to match the two parties such as their location (their relative distance), product availability (what times is the product available), material composition, sizes, for how long the product is available and pricing.

The AI can process different complex parameters to create clusters of lessors, lessees, sellers and buyers to find the most optimal matches. Platform owners, for example companies, banks or municipalities, also stand to gain through a commission-based system enabling successful matches.
An added benefit of doing this digitally is the ability to track product or material usage and create reports.  These can be shared with authorities that monitor circular economy practices. For example, a company required to report its contribution to circular economy can use such platforms to automatically create supporting documentation in the form of certificates, product usage and the like.

## Production, maintenance & analytics

Design plays a crucial role in product lifecycle  – creating good quality modular products, where parts can be easily replaced, upgraded or adjusted, will extended the life of a product. Another way to minimize the manufacturing of new products, and hence decrease the required raw resources and associated carbon dioxide emissions, is to prolong an existing product's useful life via maintenance: repair, refurbishment, upgrade and adjustments. Extending lifecycle would decrease product's likelihood of ending up in landfill too early and increase its chance to be used optimally.

Certain items, for example, cars, are subject to regular maintenance whilst others, such as consumer electronics or white goods, are often ignored in this aspect.
Today's technology enables us to monitor all kinds of devices by using

Internet of Things (IoT) sensors or smart meters that relay information about a product's operability.

A result of this connectivity is that the state of equipment can be constantly monitored and AI algorithms can learn patterns that are able to inform if a device is healthy or requires maintenance. For example, IoT sensors attached to white goods such as a washing machine can monitor the vibration frequencies during usage. This allows to establish normal behavior limits and determine when deviations from these occur with statistical significance.

For electronic devices, such as TVs or entertainment box-sets, sensors can monitor circuit signals to determine normal operation variables such as the frequency and amplitude of power through the device. In all cases, the information can be used to detect when a device is starting to illustrate signs of failure. In such cases the device manufacturer and owner can be informed to perform product maintenance.

## Resource & waste monitoring

It's estimated that currently more than half of the world is living in urban areas, a figure expected to increase to 68% by 2050. Whilst we think of cities being hubs of activity, we are currently witnessing the rise of megacities, cities with more than 10 million inhabitants[15].

With so many people living in such close proximity monitoring and managing resources, such as water, waste and non-recyclable goods becomes a necessity for future of these municipalities and smart (mega)cities.

- IoT connected smart meters can be used to monitor electricity consumption or water usage. AI algorithms can process the data to define optimal consumption behavior at the microscopic level of individual consumers and prevent wastage when consumption is found to be irregular.

- AI can also monitor and detect potential breakages and dysfunctionalities impacting effectiveness of daily infrastructure. For example, WiFi enabled cameras and weight sensors can be used to monitor the state of green recycling points or waste collection hubs, alerting operators to when sites need emptying.

- AI can also assist with waste and materials sorting, enabling their proper separation and collection for potential secondary use. While this can be done on municipality and company level, AI could assist also with waste management at source – during the growing and extraction phase, at the production site and in the home.

## Agriculture & food production

Current food production methods will soon not be sustainable if we take into account the rise in population. With figures estimated to reach 8.5 billion by 2030 and 9.7 billion by 2050 respectively[16], more efficient farming and food production methods are required. Clearly squander of natural resources such as water must be minimized.

Areas where AI can help include monitoring the crop growth process, from nutrient supply all the way to harvest. For example, environment factors related to growth such as soil humidity, nutrients and pest control agents can be monitored in such a way that crop Is not unnecessarily watered or supplemented with nutrients. An AI algorithm can learn the optimal values on a case-by-case basis.



AI driven computer vision can be used to detect when the crop is mature enough to be harvested (e.g. detecting fruit color and estimating crop size), or to detect weeds in soil and remove them before they have an adverse effect on crop growth. Computer vision algorithms can also be harnessed to detect crop shape. Consumers have associated certain fruit or vegetables with the "perfect shape" and shy away from buying any food that does not meet their standard. Imperfectly shaped crop can be detected during harvest and valorised in other parts of the food industry so that no crop is left unused.
AI can also be used to inform producers on how much crop to grow and when to grow it. Demand patterns can be established by monitoring sales of food in supermarkets, to detect seasonal activity and to predict future demand. Such information can be relayed back to crop growers to ensure that their efforts are targeted, allowing supply to meet any demands without food being wasted.
Another important application of AI is in water management. With the world to experience a 40% global water deficit by 2030 under projected climate scenarios[17], water-related risk management is an increasing priority for government, private sector and society generally.
AI can contribute to more effective water treatment processes and better water infrastructure management by detecting potential defects ahead of time. Thanks to machine learning, new insights can be created enabling better water reuse and its discharge. AI can play a crucial role in water supply and sanitation, ensuring water quality and proper treatment standards. For water utility companies, AI can create an overall monitoring system leading to optimized water supply for planning and predicting future investment requirements.

## E-healthcare

Article 25.1 of the Universal Declaration of Human Rights states that everyone has the right to an adequate standard of living, including health and medical care[18]. Careful design of healthcare provision cannot be ignored when facing an ever-increasing population.

From hospital care to clinical research, insurance, diagnostics and drug development, AI applications are revolutionizing how the health sector works to reduce spending and improve patient outcomes.

The total public and private sector investment in healthcare AI is expected to reach 6.6 billion USD by 2021[19], according to some estimates. Even more staggering, Accenture predicts that the top AI applications may result in annual savings of 150 billion USD by 2026[20].
One future possibility in this context is the creation of sharing platforms and using specialized equipment with a Product-as-a-Service (PaaS) model. As indicated earlier, AI can assist by connecting patients with experts (e.g. remote surgery) or specialized equipment access (e.g. when and where to use such equipment).
Instead of having patients visit doctors for checkups, smart sensors (e.g. smart watches) can monitor vital signs and AI software can be trained to detect signs of abnormality or signs that are indicative of deteriorating health. In this way, both transportation, with its associated environmental impact, as well as unnecessary visits to doctors, can be minimized. In the event of detecting abnormal signs of behavior the AI can alert both the physician in charge and the patient to schedule an appointment.
Furthermore, and subject to the patient's consent, the smart sensor data can be logged and transmitted to the physician assisting in having a meticulous patient history record, informing any future consultations.
AI-driven computer vision can assist in many aspects of healthcare. For example, routine diagnosis of simple bone-fractures from X-rays can be

implemented using AI. The AI can identify parts of a body and whether a fracture exists, freeing up valuable time for doctors to attend to more urgent matters.
Computer vision can also help in sorting material into biohazard or "other" categories making waste management more efficient. Finally, AI can be used to support digital text analysis; lengthy patient history records can be summarized, or previous diagnosis and treatment parsed from the text and presented to physicians.

## Regulation, Reporting and Risk Management

The financial and regulatory services industry is heavily burdened with bureaucratic procedures. From thorough risk assessment, measuring, monitoring and reporting, through activities linked to new clients signing up to products and services, all the way to various documentation needed to be produced and audited.
A lot of mistakes occur due to human error while performing such activities. Automation and leveraging AI capable of processing complex data quickly and efficiently can lead to better quality results and more precise information. Additionally, it would enable more time for strategic reviews and specific situation considerations. After documents and databases have been digitized, many of the processes can be automated and performed by AI software. For example, when a person opens a bank account the bank needs to perform a Know Your Customer (KYC) process, for example to determine whether their potential client is associated with criminal activity, as checking the criminal activity is not the only reason why KYC is performed.

Personal details, such as those found on a national identity or passport document, are required at the very least. The process can be automated with computer vision software to extract such information from official documents (or even check document validity). A new customer can sign up simply by uploading a picture of an official document and the subsequent process of data extraction checks against databases. Risk classification can be performed by a series of AI algorithms found in the computer vision, natural language understanding and classification domains.
In retail, AI can be utilized to enhance transparency – whether it is the material composition, country of origin, levels of chemicals and other monitored substances, volumes and expiry dates. Reporting on how many products sold originate from circular rather than linear economy sources is now achievable. Tagging products with CE-identifiers and monitoring sales can enable quick and easy reports to be generated and shared with auditing bodies.

A growing body of research suggests that adopting Circular Economic principles can improve management of structural business risks. A recent Global Commission on Adaptation report[21] found that investing 1.8 trillion USD over the next decade in five key climate adaptation strategies would lead to 7.1 trillion USD in total net benefits.

Another survey found that while 72% of suppliers believed climate risks could significantly affect their business operations, revenue, or expenditure but only roughly half were managing these risk[22]. Redesign and optimisation of supply chain - which is the cornerstone of circular business models, can provide more insights into risk distribution across various steps and partners in the value chain. This can increase precision and flexibility of risk models and resilience to climate risks.

For instance, more accurate risk assessment of suppliers in regions exposed to negative effects of climate change or heavily reliant on limited natural resources – such as water, fossil fuels or rare materials.  AI-based algorithms present opportunities to improve risk management and decision making processes by discovering such trends, optimising risk models, scenario analysis, formulating climate and environmental adaptation strategies and improve risk reporting.

## Education & engagement tools

The transition from a linear to a circular economy is a gradual task. Educating employees and all end-consumers about circularity, its principles and the associated impact on the global economy is much needed. In line with CE principles, digital education resources can be used to inform and educate people.

The digital avenue is important here, as it is a way to reduce resources such as printed paper and minimize waste. Also, a digital solution requires less physical infrastructure in the form of brick-and-mortar school buildings, so can be accessible to more people at the same time, spreading the CE message to everyone efficiently and cheaply.

AI 'chatbots' can be purposefully built to engage with customers and employees of a company. From a customer's perspective, conversational agents can be used, for example to answer queries such as origin of materials, what circular principle is behind their product or what are the eligibility criteria to be considered for Circular Economy loan.

From the employee perspective, chat bots can be used to educate people on CE principles of a company and to illustrate how formerly "linear" internal procedures can be changed based on CE practices. This concept can be enhanced with gamification tailored to user experience functionality.

The engagement of customers and employees in the above scenario can be monitored using sentiment and emotion detection algorithms to understand whether they are receptive of the provided lesson, and if not either adjust the delivery or find new ways of presenting the educational material. Ultimately AI can be used to augment the abilities of the person responsible for CE education and make their work more targeted and efficient.

# CONCLUSION

AI and CE practices harnessed together can transform the world's overall economic system, benefiting organisations, people and the planet.  It's becoming more obvious every day that our current system and economic processes and practices must change.

Action is needed now. Everyone has a role to play. Governments can help by creating regulations and policies enabling and accelerating the implementation of new technology and business models, which can help to scale more restorative practices.

Businesses have the opportunity to look into their current practices and identify relevant models that can provide a unique competitive advantage - from strategy, sustainability and risk management as well as from a financial perspective.

Investors can stimulate the transition to Circular Economics through increased mobilization of capital towards businesses developing and scaling AI for appropriate reasons.  These investment strategies also carry the potential to reduce climate risks within investment portfolios.

Individual people have a democratic right to raise their voice regarding what future they want - through voting, purchase decisions and conscious consumption. Together, this way, we can all accelerate the transition to Circular Economic practices.

We would like to invite businesses, government officials, or anyone in a decision making capacity, who would be able to contribute towards and benefit from Circular Economy opportunities, especially those driven by AI, to contact us.  MissionC and Fountech will be happy to examine your organisation's services, products and procedures - to assess how to future proof your business while contributing to a more sustainable future.

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# ABOUT US

## MissionC

MissionC is a strategy advisory firm based in Amsterdam, helping organizations to bridge the gap between business and sustainability. Our mission is to accelerate the transition to Circular Economics and a sustainable future on a global scale.

We team up with business leaders and passionate change-makers from all sectors to multiply our impact and drive this global change together. We are helping organizations to realize the opportunities of CE to future proof their business - from strategy to practical solutions and their implementation.

We combine our background in strategy, finance, risk, digitalisation and sustainability to connect 'doing business' with 'doing good'. Whether it is redesigning your strategy, designing employee and engagement training programs, utilising technology to boost circular revenues, connecting the private and public sectors on national levels for circular transition, or advising circular start-ups on their investment propositions, we are committed to deliver tangible results and measurable change.  To read more about us, our mission and service offering, please visit the **MissionC** website.

We have been featured in various **media**. We love to spread the circular message through our consulting projects, events, workshops, public speaking, publications and start-up mentoring.  If you would like to be a part of the circular revolution, our mission is to help you. If you would like to explore the opportunities Circular Economy can create for YOUR organisation, **get in touch with us to discuss how we can help to futureproof your business: info@missionc.nl**

# Fountech

Fountech is an Artificial Intelligence (AI) think-tank. We have designed AI solutions for a variety of industries, such as automotive insurance, hospitality, sales lead generation, energy arbitrage and supply, global educational technology and much more.

Our press coverage is well established, as we are a worldwide authority on AI integration and design, having worked in the USA, Europe, Asia and the Far East. We are regularly featured and referenced in international publications, as seen in our **media summary.** You can also view or sign up to our **newsletter**.

We provide seemingly simple solutions (even though they really are not!) to complex business problems using Big Data and disruptive technologies. To find out more about Fountech generally, please visit our website; **https://www.fountech.ai** or download our **e-brochure.**

To find out more about our methodology when we work with customers, please **see our methodology overview.**

We would love to connect with you on Twitter, LinkedIn and Facebook.

### *The Fountech approach – Thinking AI*

The creation, application and integration of AI is part of what we do. Our experience and expertise enable us to identify ways we can empower your company by analysing your needs and proposing custom AI applications that are most suitable to you, rather than relying on text-book solutions. In this context, "we don't just apply AI, we think it". Fountech know how to integrate technology into businesses because we understand primarily that return on investment is as crucial as providing an efficient solution to a given problem. Fountech's CEO and serial entrepreneur, Nikolas Kairinos, has taken numerous tech start-ups from a zero balance sheet to having raised millions in investment capital; consequently, we understand the concept of bridging the gap that sometimes exists between technical and business people, to create products that return tangible results.

### *Contact Us*

We are keen to hear from those interested in using our services to put themselves ahead of their competition. We often work by answering your – "What if we only knew...?"' question, where the answer would revolutionise your profitability and your customers' experiences.

Every time you learn new ways about putting your business forward, so do we. That's why we're so keen that you ask us your burning question, So, don't hesitate, why not **contact us right now for an absolutely obligation-free initial consultation: ai@fountech.ai**

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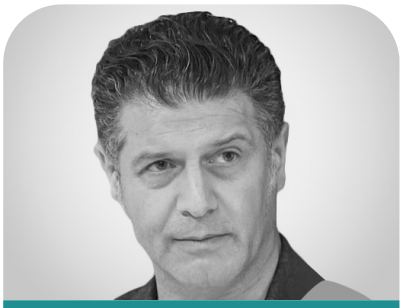

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