FROM A LINEAR TO A CIRCULAR ECONOMY

Experiences from Denmark and New York on closing the loop through partnerships and circular business models

DANISH CLEANTECH HUB

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ABOUT THIS PUBLICATION

Circular economy is high on the international political agenda. However, we are only at the beginning of the journey towards becoming a circular economy. International co-operation and transatlantic knowledge sharing is crucial in converting challenges into opportunities at a city, regional and global level.

This publication is the outcome of a yearlong exchange of knowledge and experience between Denmark and New York, initiated by State of Green and implemented in collaboration with Danish Cleantech Hub in New York. The core of the project was a week-long circular site visit tour to Denmark for a group of selected New Yorkers representing both the public sector, the research community, impact investors, and international organizations. This group of New Yorkers, in close collaboration with their Danish counterparts, have been instrumental in facilitating and continuously expanding solution sharing between Denmark and New York, through seminars and co-creation workshops, proving an effective vehicle for transatlantic dialogue.

This publication's purpose is to contribute to this exchange of ideas on circular economy, and through practical examples illustrate how Danish and New York stakeholders are providing solutions that help progress the transition towards a circular economy.

Hopefully, this publication will inspire people to progress the transition towards a circular economy.

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FOREWORD

We are experiencing a period of change more rapid than any other in human history. Automation, the gig economy, and digital technology are transforming the way our goods are produced, the way we work, and the way we communicate.

Kate Daly, Executive Director, Center for the Circular Economy @ Closed Loop Partners

This moment of exponential change, characterized by some as the fourth Industrial Revolution, brings many challenges but is also an opportunity for us to harness emerging technologies to address the most dysfunctional and unsustainable legacies of the first three Industrial Revolutions, and to disrupt business as usual with innovative new approaches. But we need to act fast.

Our sense of urgency comes from the fact that in 2012 the world's cities generated 1.3 billion tons of solid waste, a number that is expected to rise to 2.3 billion tons by 2025 due to population growth, rising middle-class consumption, and increased urbanization. Our traditional models of growth and prosperity have not kept pace with our world's exponential growth, technological developments, and new opportunities. Nations spend billions of dollars annually to landfill resources that are themselves worth billions of dollars.

The $1 trillion question before us all is: how do we turn this waste into revenue and jobs? How do we together transition from a "take, make, waste" economic model to a circular "take, use, share, return" model? This emerging model is relevant to industries that play an important role in all of our lives, from the food we eat and the clothes we wear to the buildings we inhabit. Our planet's raw materials are finite, but a circular economy, in which we take full advantage of currently untapped resources, allows for systems change without sacrificing economic gain.

Cities are in a unique position to question all the assumptions of the linear economy and create new opportunities for job creation and prosperity. New York City represents a huge market for goods and is home to anchor industries like financial services, manufacturing, tech, real estate and fashion that could be market leaders in the transition to a circular economy. And in this transitional moment, we have the opportunity to identify what it would look like to create an equitable, inclusive economy as new, circular business approaches create the jobs of the future, both high-tech and low-tech.

New York City's ambitious policy goal of zero waste to landfills by 2030 and its commitment to an 80% reduction in greenhouse gases by 2050 demand innovative solutions. New York City's robust supply of talent, capital, and thriving tech ecosystem is a strong platform from which to catalyze those solutions. New York City is powerfully positioned to capitalize on circular economy principles that reflect market opportunities: decoupling growth from consumption, design that incorporates modularity and upgradability, technological innovation, and new sharing economy and product as a service business models.

New York City's support of innovative technology and design is only a first step in catalysing profitable solutions to the City's own circular challenges, and driving business growth across multiple industries. But we can't do it alone. We have much to learn from efforts across the globe, and the circular solutions and technologies that are already being implemented in those cities and nations who have made the transformation to circularity a top priority.

Denmark has long focused on increasing recycling rates and utilising waste streams, and has identified significant opportunities for these areas to positively impact economic growth while resulting in environmental benefit. The strength of these efforts derives from a collaborative approach, as the Danish government works closely with the private sector and academic institutions to develop strategies that will accelerate the circular transition. Cities around the world, from Copenhagen to Tokyo to New York City, are demonstrating leadership through partnerships with philanthropy, research institutions, emerging and established companies, and entrepreneurs, who together form an ecosystem of innovation that is critical to disrupting linear systems and tapping new economic opportunity.

Collaboration and public-private partnerships across industries, across cities, and across nations is critical as we work together to solve these urgent challenges and generate jobs and prosperity. Together we can create a shared vision for the circular city.

Kate Daly
Executive Director
Center for the Circular Economy
@ Closed Loop Partners

CREATING CIRCULAR FRAMEWORKS

The transition to a circular economy requires holistic approaches and frameworks.

To capture the immense potential and benefits of the circular economy, high levels of coordination across sectors and public-private divides are necessary.

In Denmark, a growing national political willingness to spearhead and coordinate the development of holistic policy frameworks is arising, whereas the progress in New York has largely been driven by voluntary standards and private initiatives. Although the goals are similar, the mechanisms, incentive structures, nature of benefits and barriers that each approach can overcome varies. Closer cross-Atlantic collaboration could allow for greater sharing of best practices and a deeper understanding of the differences in drivers. This could ultimately enable both Denmark and New York to create more advantageous circular frameworks and conditions.

Voluntarism spurring circular frameworks

Companies, organizations, public-private initiatives, and collaborative partnerships have become the main initiators of large-scale certification schemes and international platforms. Each of these engages cities, industries, or subsectors in coordinated efforts to increase circularity.

A common denominator of the voluntary platforms is how they aim to increase participants' ability to implement circular economy principles into their respective core strategies, which are primarily based on considerations of long-term profitability potential. International examples include CE100, Project MainStream and Circular Cities Network – the latter of which New York City and Copenhagen are members of.

"The transition to a circular economy is a systemic change. In addition to targeted actions affecting each phase of the value chain and key sectors, it is necessary to create the conditions under which a circular economy can flourish and resources can be mobilised."
"Closing the loop - An EU action plan for the Circular Economy", European Commission

Certification and standardization schemes are also increasingly shaping circular economy conditions. In general, these schemes focus on how the private sector can apply circular product design. Environmental Product Declarations, ISO 14044 Life Cycle Assessment, and Cradle to Cradle are among some of the most influential schemes. On the part of consumers, certification schemes also support more active and informed choice by giving users better tools to evaluate and select goods.

Policy and the circular economy

In their 2015 case study of Denmark, The Ellen MacArthur Foundation estimates that national GDP may increase by 0.8-1.4 percent by 2035 if principal steps towards a circular economy are taken. A combination of public-private collaboration and coordinated policy efforts are key to obtaining this goal. Barriers related to cross-sectoral and non-financial issues must also be addressed. Working cooperatively should therefore not be limited to voluntary initiatives. It must also apply for legislative efforts.

Holistic political visions and frameworks, like the EU action plan for the Circular Economy from 2015, can also be instrumental in sending clear signals to economic operators. Likewise, transnational political visions may also enable more cohesive legislation within areas such as solid waste management, building codes, public procurement policies, environmental standards and the creation of well-functioning secondary markets.

CLOSING LOOPS

Using resources for the longest time possible could cut same nations' emissions by up to 70%, increase their workforces by 4% and greatly lessen waste.

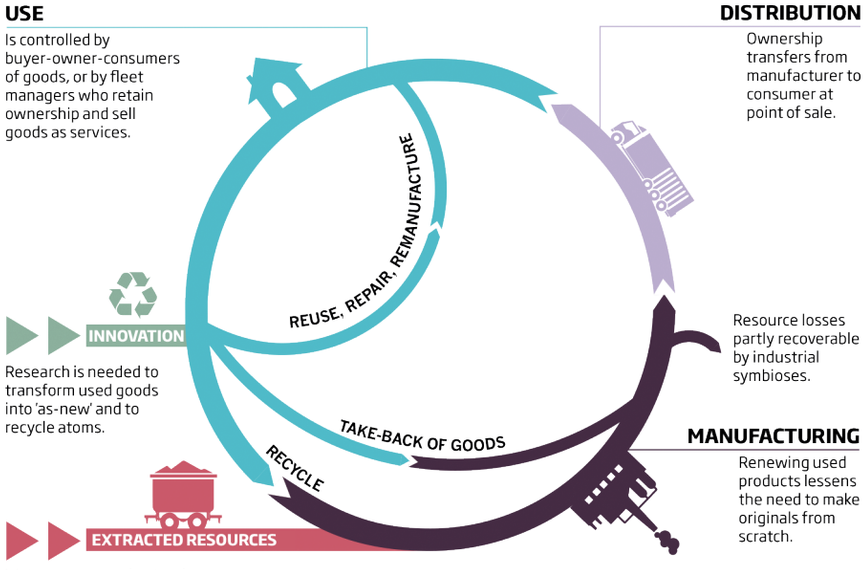


Illustration: Nature Publishing Group

The importance of Cradle to Cradle Certification
The Cradle to Cradle Certified™ Product Standard, founded by William McDonough and Michael Braungart, guides designers and manufacturers through a continual and systematic improvement process that looks at a product through five parameters – material health, material reutilization, renewable energy and carbon management, water stewardship and social fairness. The third-party product certification program is independently administered by the Cradle to Cradle Products Innovation Institute. Hundreds of companies have designed, manufactured and optimized thousands of products using the guidance the program provides. Since its initiation, Cradle to Cradle Certified has become one of the most well-known product certification standards for the circular economy and its impact is continuously being documented. For companies, the certification process has brought benefits such as reduced costs, improved product value, new revenue streams and it has helped companies become front-runners in the transition to the circular economy.

Cradle to Cradle Products Innovation Institute

A national advisory board for circular economy in Denmark
In 2016, the Minister for Environment and Food, and the Minister for Industry, Business and Financial Affairs established the Advisory Board for Circular Economy. Consisting of 12 Danish business leaders from a range of different industries, the board was tasked with developing a vision for Danish businesses' transition towards a more circular economy, and compiling a set of recommendations to the Danish Government for how to create the legislative framework needed to allow for this transition.

In 2017, the Advisory Board delivered its vision, along with 27 recommendations to the Danish government ranging from suggestions for improving waste legislation, to advancing tech startup innovations, increasing resource efficiency and encouraging public procurement to focus on circularity. The Advisory Board has been instrumental in creating cross-sectoral understanding in Denmark of the challenges and potential that the circular economy entails, as well as promoting a national legislative framework that can help break down barriers associated with moving from a linear to a circular economy.

Ministry of Environment & Food,
Ministry of Industry, Business and Financial Affairs

Illustration: Danish Ministry of Environment & Food, Kontrapunkt

DESIGNING CIRCULAR BUILDINGS

Tapping into the circular potential of rethinking the built environment.

Circular economy principles could offer the construction sector a transformative possibility by considering concepts such as modular design, prefabricated and off-site construction, design for disassembly, materials recycling and designing out waste.

The engineering and construction industry is the world's largest consumer of raw materials. It accounts for 50 percent of global steel production and consumes more than three billion tons of raw materials. The trade between the US and Denmark within the construction sector reached $US 205 million in 2016. These well-established trade relations create a solid foundation for exchanging know-how and solutions related to designing circular buildings.

Architectural traditions

The collaborative potential between Denmark and New York not only rests on trade relations. It is also rooted in a joint interest for spectacular and modern architecture. During the last decade, signature buildings from Nordic architects such as White Architects, BIG Group, and Snøhetta have become part of the iconic New York skyline. These have paved the way for a growing New York interest in Nordic design philosophy, material choices, and building traditions. Optimizing exchange of the considerable amount of circular know-how and best practices being developed currently would be a natural continuation of this exciting collaboration.

Denmark and New York also share a willingness to let cities become architectural playgrounds. To advance circularity in the built environment, a range of different stakeholders must engage and invest in new solutions. In Denmark, public housing and municipal buildings are among the first movers. In New York, large and progressive universities and real estate companies represent an enormous potential for advancing circular buildings.

"Better construction and use of buildings in the EU would influence 42 percent of our final energy consumption, about 35 percent of our greenhouse gas emission and more than 50 percent of all extracted materials"
"Roadmap to a Resource Efficient Europe", European Commission

In addition to passionate building owners, the design of circular buildings also requires the involvement of architecture, engineering and the construction industry to break down silos. Looking at these subsectors as one common industry will be essential in supporting the necessary innovation and building the value chain collaborations that are central to the circular economy. Both Denmark and New York are home to forward thinking businesses in this industry, increasing the collaborative potential.

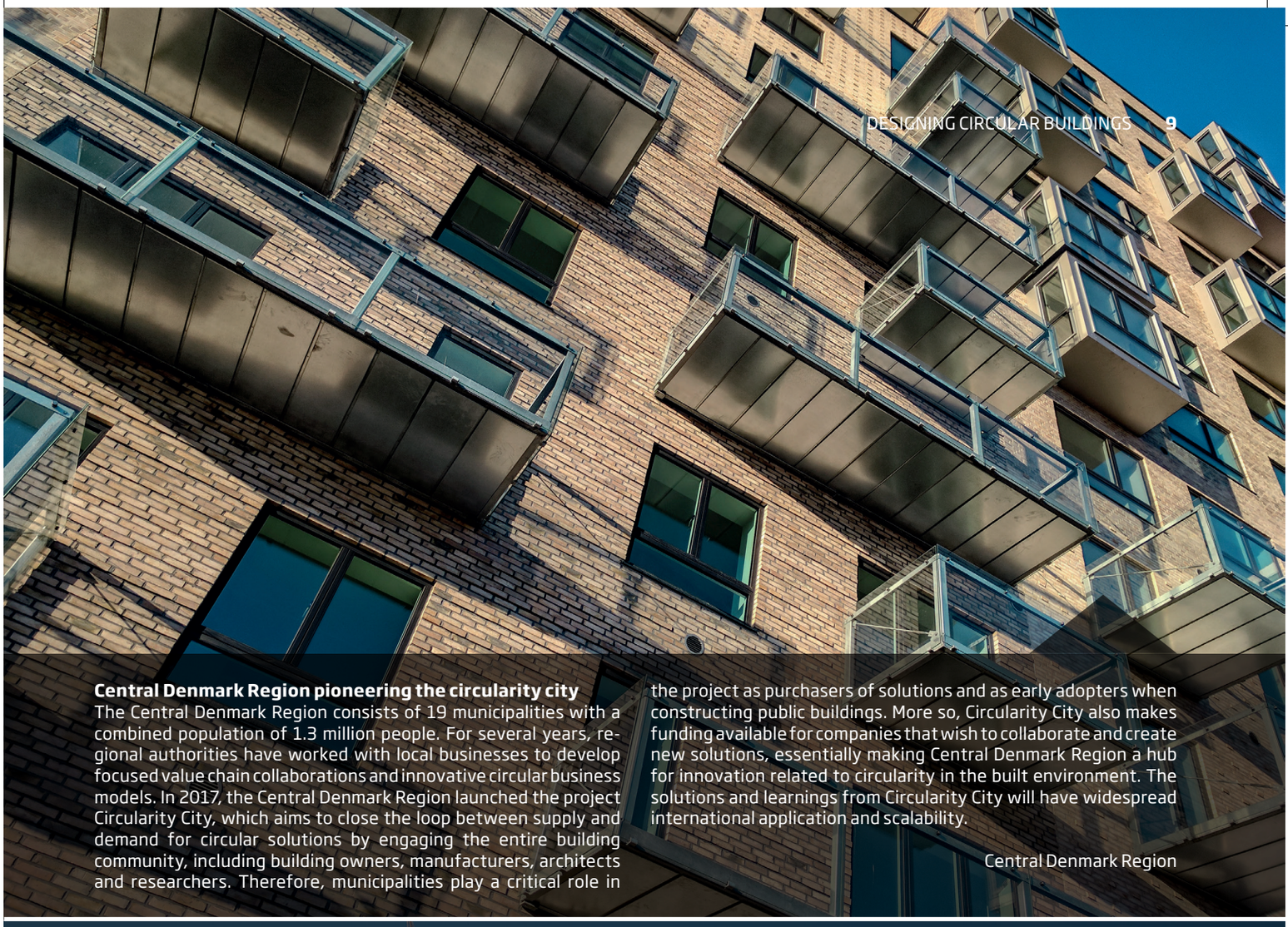
Supporting local goals

Circularity is not only an applicable approach when building from scratch. The mindset can also guide retrofit strategies or enable upcycling of buildings, which enables energy savings and emission reductions from buildings. In a city like New York, where it is expected that more than 90 percent of the one million buildings that exist today will still exist in 2050, such an approach is vital for the scalability of circular solutions. Subsequently, circularity in the built environment can also be a driver to reach local climate goals. In the case of Copenhagen, buildings play a crucial role in the city's plan to become carbon neutral in 2025. The same is the case for New York City and its objective of reducing carbon emissions by 80 percent by 2050 and the city's commitment to the Paris Climate Agreement.

A cross-Atlantic partnership for circularity

The Circularity Lab is a cross-Atlantic partnership between Google, Arup, Turner Construction, and 3XN Architects/GXN Innovation. Initiated in 2017, the partnership aims at exploring the use of circular design principles in architecture, engineering, and the construction industry. Furthermore, it seeks to illustrate state-of-the-art solutions related to circular building products, materials tracking, and design for disassembly. The partnership will construct full-scale prototype buildings in the San Francisco Bay Area in order to display these solutions. The Circularity Lab is a further development of The Circular Building, which was displayed during the London Design Festival in 2016. This project will play a vital role in creating awareness in the US about the possibilities and the immense potential circular building principles have to alter how buildings are constructed.

Google, Arup, Turner Construction, 3XN Architects



Central Denmark Region pioneering the circularity city

The Central Denmark Region consists of 19 municipalities with a combined population of 1.3 million people. For several years, regional authorities have worked with local businesses to develop focused value chain collaborations and innovative circular business models. In 2017, the Central Denmark Region launched the project Circularity City, which aims to close the loop between supply and demand for circular solutions by engaging the entire building community, including building owners, manufacturers, architects and researchers. Therefore, municipalities play a critical role in the project as purchasers of solutions and as early adopters when constructing public buildings. More so, Circularity City also makes funding available for companies that wish to collaborate and create new solutions, essentially making Central Denmark Region a hub for innovation related to circularity in the built environment. The solutions and learnings from Circularity City will have widespread international application and scalability.

Central Denmark Region

Developing zero waste guidelines for building design

In 2017, the American Institute of Architects New York, with support from the Rockefeller Foundation, published the Zero Waste Design Guidelines. The guidelines address the crucial role that design plays in achieving NYC's ambitious goal, outlined in OneNYC, to send zero waste to landfills by 2030. Material management such as energy and water management needs to be designed into our buildings and public spaces to reduce the generation of waste and increase the diversion of recyclable materials.

The authors of the guidelines - Clare Miflin, Juliette Spertus, Benjamin Miller and Christina Grace - developed the guidelines through multidisciplinary workshops with 100 collaborators including architects, planners, developers, city officials, recycling experts and building managers. With the publication, the New York building industry has risen to the challenge of designing buildings with circularity in mind and created a tool with both local and global potential.

AIA NY Committee on the Environment,
Kiss + Cathcart Architects, ClosedLoops & Foodprint Group

UNLEASHING THE CIRCULAR POTENTIAL OF BIOWASTE

Biodegradables, food and organics hold a large untapped potential for circularity.

A circular economy aims to keep products and materials at their highest utility and value. Nonetheless, waste is a reality, but circular strategies can be applied to prevent waste, finding ways to transform by-products into high-value ones and increase recycling.

Preventing organic waste and capturing the full value of biowaste streams will be central in the transition towards a circular economy. Denmark and New York could gain from tapping into each other's strongholds within areas such as food processing and organic collection systems.

Industrial by-products

The food production sector holds great potential for the utilization of side streams and the efficient use of by-products with the key being to maximize resource efficiency and minimize waste. The principle is called profit-driven cascade utilization or bio refining, a method for increasing the value of side streams.

In Denmark, the country's biggest meat processing company, Danish Crown, manages to use all parts of the pig's carcass in their production chain. Similarly, dairy producers take advantage of the by-products from cheese production to make high-protein products for the pharma industry, while the Danish potato processing industry transform residual potato fibers into a protein-rich food additive. Any final biodegradable waste from these industries are presently co-digested with farm slurry and used for agricultural purposes. Modeling suggested that if cascading bio refining within the food and beverage industry was fully applied, it could yield a yearly net value of EUR 300-500 million in Denmark alone.

Household biowaste

In New York City, more than 3 million tons of residential waste is generated annually. Of this waste stream, it is estimated that up to 31 percent consists of food scraps, garden waste and soiled paper suitable for recycling. To capture the value of this biowaste, and the remaining waste stream, the City of New York has committed itself to send zero waste to landfills by 2030. This ambition is an element of the city's plan to reduce emissions and dramatically increase recycling. As to reach this zero waste goal, the city has initiated a wide range of volunteer initiatives that aim to educate citizens, increase biowaste collection, increase the use of anaerobic digestion and minimize waste generated. Learnings generated from this program may very well also prove useful in a Danish context. For instance, the Danish Environmental Protection Agency has estimated that 56 percent of the food waste generated by Danish households is avoidable. To address this challenge, informing and educating consumers should be a priority. This shared set of challenges create strong incentives to share best practices and further develop knowledge sharing between public agencies and private partners in Denmark and New York.

Large scale collection of residential organic waste in New York City

With the Organics Collection Program, the City of New York has initiated the largest residential program for collection of organic waste in the US. The program ensures the distribution of organic waste bins for households. All New Yorkers will receive either curbside service or have access to convenient neighborhood drop-off sites. Furthermore, the program also requires planning and collaboration with both public and private stakeholders to receive and manage the waste. This includes expanding compost facilities, as well as co-digestion capacities at wastewater treatment plants. Though these steps may be associated with initial costs, the purpose of the program is to create long-term solutions and unleash the business potential of unused biowaste.

New York Department of Sanitation

Dissolved organics from unsorted waste for biogas

With the development of Renescience, the Danish energy company Ørsted has made it possible to extract organic matter from unsorted household waste. This is possible by the application of an innovative technology that intelligently separates waste using both mechanical sorting, enzymes, recycled water and anaerobic digestion. The plant sorts unsorted waste into three groups. First, recyclable plastic and metals. Second, non-recyclable materials such as textiles. Third, a fluid made from the dissolved organic parts of the waste, which is then converted to biogas. With this innovative technology an empty juice carton is no longer an obstacle to recycle, as the plant can dissemble both the outside paper, the inside foil, the plastic skewer cap and even the pulp of juice leftovers.

Ørsted

Photo: Ørsted

CIRCULAR FASHION AND TEXTILE PRODUCTION

Changing the environmental impact of the textile industry.

Global apparel consumption is projected to rise by 63 percent, from 62 million tons today to 102 million tons in 2030, emphasizing the need for strategies to increase circularity in the fashion industry.

Encouraging a circular fashion economy

In May 2017, global fashion brands and retailers came together in Copenhagen to accelerate the transition to a circular fashion system, by signing the 2020 Circular Fashion System Commitment. Industry leaders such as Adidas, Bestseller and Eileen Fisher pledged to implement design strategies for recyclability, increasing the volume of used garments that are collected and resold, and to increase the share of garments made from recycled post-consumer textile fibers. With current signatories representing 7.5 percent of the global fashion market, this signals a significant step towards the creation of a circular fashion industry.

This move towards circularity is also a response to fast fashion, which currently means that half of global clothing production is discarded within less than a year. Long lasting designs, as well as high-quality and carefully selected materials is intended to secure longer usage of an item, enabling several reuse-cycles, as well as increasing the recycling potential. These principles represent enormous potential to create positive environmental impacts if widely adopted in the textile and fashion industry.

"If the industry manages to fully close the loop between the end-of use phase and the raw materials phase, recycling apparel and footwear waste into new input materials, the environmental footprint of the entire industry will be drastically reduced. This type of circular model is the ultimate aim of all actions targeting recycling"
Pulse of the Fashion Industry,
Global Fashion Agenda &
The Boston Consulting Group

Recycling of textiles

Capturing an increasing amount of current and future textile waste suitable for recycling is essential in order to leverage both the economic and the environmental potential. Today, there exists significant untapped potential within textile recycling, as most clothing items end up in landfills, are lost in production and only up to 12 percent is recycled for lower end use as e.g. insulation material.

This supports the need to rethink the entire textile value chain in order to improve the sector's sustainability and resource efficiency. Disruptive and collaborative actions could include the establishment of industry-wide end-of-use garment collection, new business models and a breakthrough in recycling technologies combined with continued sustainability education in order to increase consumer engagement. The collaborative potential between Denmark and New York in this regard is also promising and the sharing of best practices could stand to benefit both economies.

Image: Angela Moore

Upcycling end-of-life textiles

A central challenge for the fashion and textiles industry is how to make good use of textiles that are at the end of their lifespan. Danish company Really has taken up this challenge, and developed a range of solid textile boards and acoustic textile felts using end-of-life wool and cotton. These non-woven materials are made by blending small textile fibers with binder, a process that does not require water or chemicals. The combination of textile and binder give the boards unique properties and characteristics. The boards can be processed and treated as a wooden material, however, it is very flexible. The fabric is sourced from the fashion and textiles industry, industrial laundries, households, and cut-offs from the textile industry. To expand use practices of the products, Really collaborated with designer and material enthusiast Max Lamb for the international furniture fair, Salone Milan 2017. The collaboration led to the development of a series of innovative benches displaying the strength and diversity of the material. Really is partly owned by high-end textile design manufacturer, Kvadrat.

Really, Kvadrat

Educating the designers of tomorrow

In the world of fashion and textiles, universities are driving the erosion of inter-industry silos between designers, textile manufacturers and the recycling industry. New York universities are starting to change the way they work with fashion and design in acknowledgement of the challenges and not least the potential this field holds to increase circularity. Design schools such as the Pratt Institute, Parsons School of Design, and The Fashion Institute of Technology are spearheading the development of new materials and innovation in design practices, while also educating future industry leaders. As an example, the Pratt Institute has created an accelerator program, supported by the State of New York and New York City, that researches environmentally friendly textiles' sustainability from a business perspective. Similarly, the Tishman Environment and Design Center at The New School is contesting conventional thinking in the industry by integrating design and environmental studies, essentially ensuring a cross-sectoral work on both research and courses between the different institutes at the New School.

Pratt Institue, Tishman Environment and Design Center

THE BUSINESS OF REMANUFACTURING

Expanding the application of remanufacturing and refurbishment.

The manufacture of goods requires energy and raw materials for production input, which can be both scarce and costly. Remanufacturing of goods encompasses substantial economic potential and could help slow down consumption of our natural resources.

Companies within a range of different sectors have developed positive business cases based on remanufacturing and refurbishment. In order to expand these capabilities into new sectors, Denmark and New York have launched new, innovative initiatives, which encompass global potential, making continuous cooperation and Transatlantic learning highly valuable.

The gains of remanufacturing and refurbishment

The US is the world's largest producer, consumer and exporter of remanufactured products. As of 2012, it was estimated that the value of US remanufactured production had reached $US 43 billion and supported 180,000 full-time jobs. In Denmark, modelling suggests that increased remanufacturing within selected sectors could create an estimated potential net value of EUR 150–250 million annually by 2035. The American company CaterPillar is a good example of a company that has succeeded in systematically incorporating remanufacturing via their brand Cat Reman, that has existed since 1973. Other segments that have pioneered remanufacturing for years include aircraft components, automotive parts, electrical and electronic equipment, engines and components, medical equipment, office furniture, printing equipment as well as restaurant and food-service equipment. In Denmark, 3R Kontor specializes in the remanufacturing of used office furniture for reselling, using environmentally friendly processes, and donating excess furniture and parts to schools and charitable organizations.

"The most important market failures are the transaction costs related to finding and negotiating with new suppliers, since remanufacturing could significantly disrupt material flows across the value chain; and the uneven distribution of knowledge among manufacturers about the economic potential of remanufacturing and new business models."
Ellen MacArthur Foundation

Overcoming conventional challenges

Even though the potential gains are often noticeable, remanufacturing and refurbishment can be challenging. It can be troublesome for the manufacturing industry to establish take-back systems and ensure the components remain in good condition many years after initial production. Innovative businesses in Denmark and the US have overcome these challenges by rethinking the design of components, employing reverse logistics, business models and creating new recycling systems. Utilizing this experience across the Atlantic and highlighting best practices will be vital to expand awareness and to accelerate the transition.

For several years the American mass retailer Walmart, has sold refurbished electronics in their stores, a practice that is becoming more widespread in Denmark. Challenges to increase the popularity and availability of these often price-reduced products include consumer education, product transparency and large-scale take-back systems. When it comes to large-scale refurb business models, Denmark may be able to learn from American successes and frontrunners.

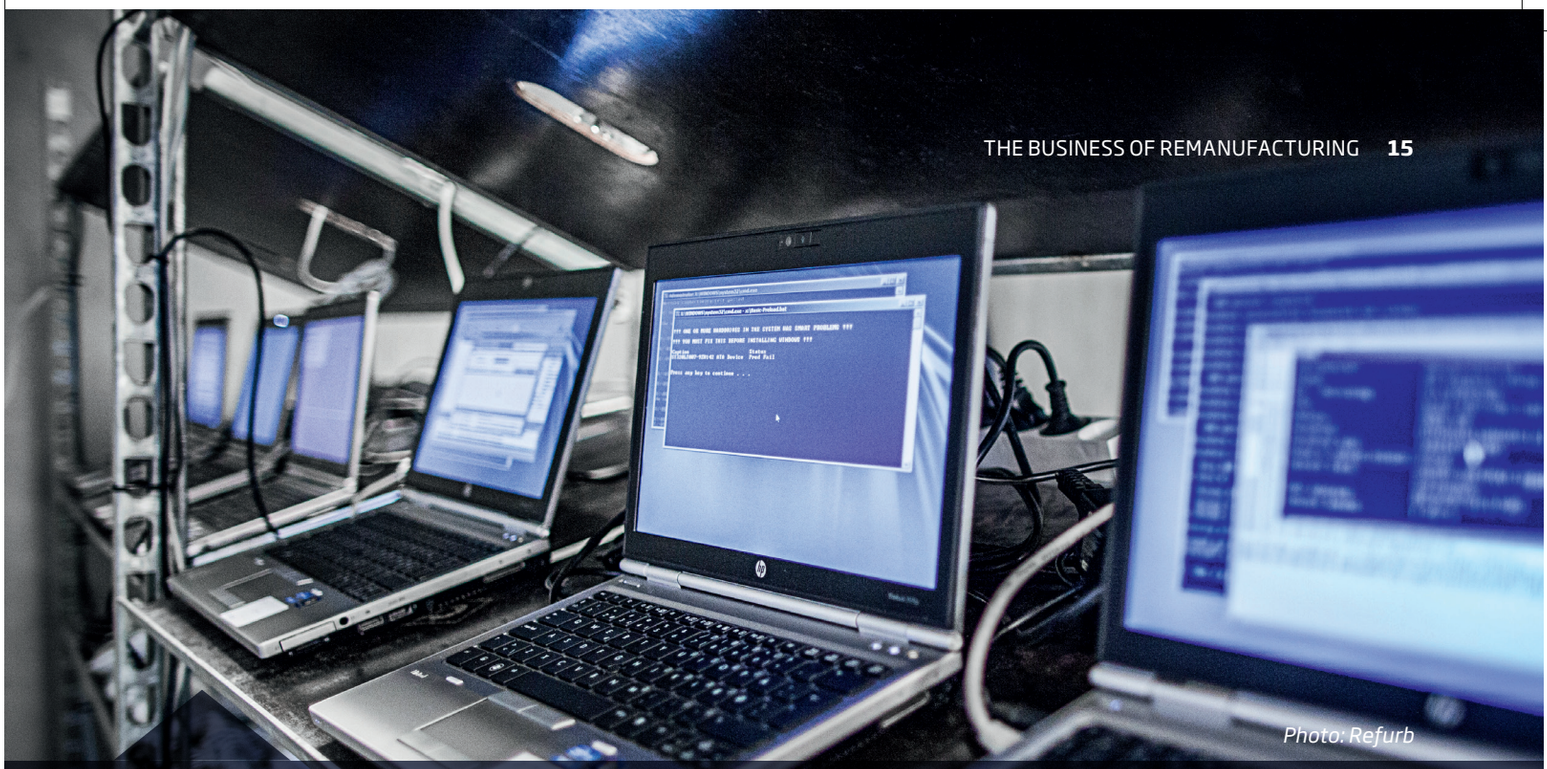


Photo: Refurb

The business of refurbishing electronics

90 percent of the components in a computer, tablet or smart phone are reusable. Since 2008, Danish Refurb has made it the core of their business strategy to refurbish used IT equipment. By reusing viable parts, the company reduces electronic waste and the subsequent environmental footprint, increases value recovery and provides customers with products at a competitive price. In order to secure the scalability of their business model and the supply of used electronics, Refurb collaborates with larger companies and public institutions, creating their own informal take-back system. The company is independent, and refurbishes electronics from companies such as Dell, Apple and HP. To ensure transparency about the product's condition, Refurb uses a grading system from A+ to C, with evaluations based on a number of criteria including cosmetic condition, performance and battery capacity. This has been a principle to overcome the challenges of consumer confidence and associated willingness to buy refurbished products. Finally, Refurb employs strategies for improving material health, using renewable energy and reducing packaging waste.

Refurb

An organic eco-system for re-manufacturers

Founded by the U.S. Department of Energy and led by the Sustainable Manufacturing Innovation Alliance, the **R**educing **EM**bodied-Energy **A**nd **D**ecreasing **E**missions Institute (REMADE Institute) is actively seeking innovative sustainable solutions to secure the competitiveness of American manufacturers, decrease dependency of scarce resources and overcome technological and economic barriers that limit the efficient use of existing resources and products. The 100+ institute partners include universities, companies, national labs, industry trade associations, and foundations. REMADE works to combine early stage applied research with the development of key industrial platform technologies. Innovations are primarily within metals, fibers, polymers and electronic waste. The technological focus areas include improving system analysis and understanding material flows, design for reuse and disassembly, manufacturing materials optimization, remanufacturing and recycling.

REMADE Institute

DATA DRIVEN CIRCULARITY

Digital technologies enable new ways of taking part in the circular economy.

The internet of things, big data and digital connectivity will allow for unparalleled data collection; providing insight into the workings of our cities and inspiring new business models.

Asset tagging and management
In the circular economy, identifying components in goods and products can be important. Tracking and collecting data from the beginning to the end of the production process and in a product enables consumers and suppliers to better extend the lifecycle, utilize or loop the asset. This has spurred the creation of product passports, which essentially are digitized information about an asset's material composition, history, or condition. Additional information regarding the location or the availability of the asset can also improve its utilization. Major American corporations such as GE, Honeywell, IBM, and Google have all taken steps towards implementing large scale asset tagging and management systems. In Denmark, the building and shipping industries are first movers within creating material passports. Combining assets tagging and geo-spatial information makes it possible to provide insight into the flow of materials, products and people across a city. This enables a more targeted and efficient planning of for instance traffic, energy demand or waste management.

The potential of connectivity
An estimated 10 billion physical objects with embedded information technology exist in 2018, and many more connected devices will follow, along with new networks for interconnectivity. This will ultimately be a vital element of creating smart and circular cities in the future. The commercial potential for both Danish and New York-based businesses within this field is enormous, as it is projected that city authorities globally will spend $US 41 trillion on infrastructure upgrades to benefit from the internet of things and real-time data in the next 20 years. In addition, the widespread and easy access to smartphones has supported a more efficient use of overcapacity enabling circular business models such as sharing and leasing platforms. This ultimately has enabled citizens to make use of the increased connectivity and actively take part in the circular economy.

Denmark and New York are both exploring the potential of these technologies, paving the way for increased transatlantic partnerships, research collaboration and commercial cooperation.

An online tracking tool for products and materials

As a compressive and growing data platform, Portico supports the management of healthy products and materials and enables direct communication between different stakeholders in the built environment. Portico was developed by the American non-profit organization Healthy Building Network in partnership with Google. This transformative open source data platform collects information from already developed standards and certification schemes such as Cradle to Cradle, the Health Product Declaration, and GreenScreen. Furthermore, the tool can host a diverse set of applications tailored to the needs of the users, thereby expanding the boundaries of the problems data can help solve. Altogether, Portico is a principal example of how data collection and asset management can support the circular economy, as this tool allows the entire building industry to track products and materials, which is a cornerstone of ensuring systematic reuse and recycling.

Healthy Building Network, Google

Material passports in the shipping industry

Through material passports, the Danish shipping company Maersk Line is keeping track of materials throughout the lifecycle of their vessels. This innovative and systematic collection of data about the materials used and their location, is expected to help Maersk Line increase recycling rates of materials used for building ships. The passport not only functions as a tracking list, it also entails guidelines for how to disassemble and recycle the materials when they can no longer be used as originally intended. This way of identifying assets is also instrumental in reducing dependency of scarce virgin resources for materials such as steel. The project requires the continuous active involvement of more than 75 suppliers and the experience generated from these efforts will be shared with the Sustainable Shipping Initiative, with the aim of broadening the application of this type of material management in the shipping industry.

Maersk Line

Photo: Maersk Line

SHARING PLATFORMS ENABLING CIRCULARITY

Unlocking the value of unused or underused assets.

Sharing economy refers to consumption through the sharing of already existing goods or products. Sharing economy platforms have become widely adopted, allowing the sharing of anything from goods, transport and space, to knowledge, money and data.

Although becoming increasingly common, the potential of the sharing economy, in both Denmark and New York, is far from realized. As innovative platforms will continue to disrupt traditional modes of ownership, users from all over the world will benefit from the sharing of ideas and best practices.

From selling a product to providing a service

The sharing economy takes multiple shapes and forms. In some cases, it enables private owners to share assets with users in need, thus increasing the asset's utilization, American company Airbnb being an example hereof. The platform facilitates connections between homeowners and travelers. By offering additional services such as insurance and secure monetary transactions, the service provides additional reliability and trust. In other cases, the sharing platform owns the goods and offers consumers the opportunity to make use of the good as a service, for shorter or longer periods. This is the case for Danish company Vigga, which is based on a subscription model that provides children's' clothes for a monthly fee. The garments are returned when the child has outgrown them. Another example is the NYC Citi Bike program, which has become the largest of its kind in the US. Since its launch in 2013, it has expanded to include more than 10,000 bikes that the more than 100,000 annual members can use whenever they need. This type of business model relies on consumers' interest in having access to a service when needed, rather than actual ownership of the product. According to studies by PwC, there is a growing willingness in the US to engage in a sharing economy transaction, with 19 percent of the total US adult population having already done so in 2015.

Unlocking the benefits of a sharing economy

The benefits of a well-functioning sharing economy include decoupling economic growth from resource depletion. Sharing platforms enable more people to gain access to certain goods or services, hence increasing availability without necessarily expanding production. In addition, the sharing economy, for instance in the form of ridesharing, can satisfy growing mobility needs, providing transportation without increasing the number of cars on the street. Similarly, apparel platforms take advantage of the fast-fashion trends that make consumers upgrade their clothes frequently. These business models could help counter the throwaway culture, while also encouraging high-quality clothes with increased durability.

Furthermore, many of the new digital platforms support cost sharing, connect people and make consumption easier.

In its recommendations to the Danish Government, the Advisory Board for Circular Economy suggests that the country increases pilot testing of new sharing economy business models and that policy-makers focus on regulatory uncertainties. On a global scale, PwC projects that the sharing economy could reach global revenues around $US 335 billion by 2025.

Circularity through wardrobes in the cloud

Since launching in 2009, American company Rent the Runway has taken the sharing economy to next level through its online platform for renting and sharing clothes. Through rental and subscription models, American customers can gain affordable access to high-end fashion items for shorter or longer periods. The company has raised $US 190 million in venture capital funding, enabling them to upscale logistics and become America's largest dry-cleaner. With a 100,000 item stock and efficient day-to-day delivery, Rent the Runway has managed to create a closet in the cloud and have succeeded in taking advantage of the fast-fashion trend and sharing economy without placing an excessive drain on resources. In addition to this, Rent the Runway has also created its own reusable eco-friendly garment bag that both protects the clothes and works as a delivery bag, thus minimizing the use of plastic packaging. On average, items are reused 30 times before being sold or donated to charity.

Rent the Runway

CIRCULAR STRATEGIES FOR PACKAGING

Innovation and value chain collaborations are central to rethinking packaging.

When dealing with consumer goods of all types, packaging is likely to be involved. The consumption of plastic packaging in particular is substantial, reaching approximately 81 million tons in 2014.

Due to the short period they are used for, packaging materials become waste fairly quickly. This is a challenge for both consumer goods manufacturers, the packaging production industry, customers and the waste management sector. The entire value chain must rethink design, use, collection, and recycling practices. In both Denmark and New York, increased awareness around the challenges of packaging are stimulating new initiatives to arise.

Design and production of packaging

Rapid innovation within packaging solutions and materials will be a central feature of tomorrow's packaging solutions. A main challenge to the implementation of new packaging solutions, however, is the considerable apparatus that is already in place to produce and use plastic centric packaging. Furthermore, the time it takes for companies to change to a new packaging design can by lengthy.

Despite these barriers, a growing body of evidence also suggest that opportunities for both small and large businesses do exist. US and Danish corporate giants such as Coco Cola Company, Carlsberg and Amazon have taken significant steps towards closing the loop by rethinking the composition and content of the materials used for packaging and to reduce waste. Similarly, smaller innovative companies are pioneering the development of new circular inspired packaging solutions.

The after-use challenges

Creating an effective after-use plastics economy will be important in creating a circular economy. The potential is huge, as the current global capture is just 5 percent of after-use plastic packaging's material value. Within other waste streams, collection rates for recycling are significantly higher. Around 95 percent of paper and cardboard is recycled in Denmark, while 97.7 percent of glass packaging is collected for recycling. The high glass recycling rates are a consequence of a long-standing deposit and return system for beverage containers. The system enables customers to claim a refund when returning bottles and cans to retail outlets and collection points. Likewise, the New York State Returnable Container Act has been highly successful. Since its passage, roadside container litter has been reduced by 70 percent, and in 2016 5.1 billion plastic, glass and aluminum beverage containers were recycled.

Nevertheless, challenges remain. To increase collection rates for recycling and improve sorting technologies, collaborative innovation is needed. Public policy, the investment landscape, and consumer education are all central elements where New York and Denmark hold complementary competences and experiences.

Investing in Circular Supply Chains

Closed Loop Partners is a New York-based social impact investment fund, investing in recycling programs, innovation, and the development of circular supply chains in North America. Funded by a conglomerate of US consumer goods companies including Coca Cola, Walmart Foundation, P&G, and Unilever, along with family offices and high net worth individuals, Closed Loop Partners' aim is to progress circularity within packaging, waste management and supply chains. This targeted strategic focus enables Closed Loop Partners to break down barriers that stand in the way of advancing circularity. Obstacles include the absence of demand for materials like glass, the uneven market for post-consumer plastics and persistently low recycling rates in some markets. Closed Loop Partners have three different investment vehicles that provide project finance, venture capital, and R&D funding respectively. This allows them to engage and fund a wide range of stakeholders including local communities, municipalities, start-up companies, industry leaders and the research community.

Closed Loop Partners

Photo: Christopher Gregory

Learn more about Danish circular solutions, find more cases from around the world and connect with Danish experts at:

stateofgreen.com

State of Green facilitates relations between Danish and international stakeholders seeking to drive the global transition to a sustainable, low-carbon, resource-efficient society. We are a not-for-profit, public-private partnership founded by:

Confederation of Danish Industry

DANISH ENERGY ASSOCIATION

Danish Agriculture & Food Council

DANISH WIND INDUSTRY ASSOCIATION

MINISTRY OF INDUSTRY, BUSINESS AND FINANCIAL AFFAIRS

Danish Ministry of Energy, Utilities and Climate

Ministry of Environment and Food of Denmark

MINISTRY OF FOREIGN AFFAIRS OF DENMARK