Annex A. Case examples

Circular supply models: furniture manufacturing at Nico Spacecraft (from National Zero Waste Council, 2015 ([1]))

Nico Spacecraft designs and builds furniture, cabinetry and interiors for the residential market. Drawing from their global experience, the owners seek their inspiration in quality, good design and environmental principles. Plywood is a primary building material, so they sought out a plywood product in harmony with their environmental ethic: Purebond® by Columbia Forest Products. Nico Spacecraft has found that the PureBond® plywood they now use in most of their projects satisfies their quality, design and environmental criteria. They also use reclaimed materials where they can. Through seeking out circular supplies for their small business, Nico Spacecraft has been able to successfully incorporate circular economy practices such as non-toxic materials, design for recycling and durability into their products.

Nico Spacecraft's circular economy commitments are demonstrated in these other wood reuse efforts:

Urban sourcing of local trees: Every few years the company comes across an opportunity to salvage trees. If the species is right, they load, mill, stack and dry it. For example, a heritage white Oak tree had to be taken down for safety reasons. The wood was used for furniture and millwork for clients.

Recycled wood: Nino Spacecraft uses recycled wood for about 20% of its projects, sourced from professional salvage companies or directly from client homes. For example, first growth fir from old buildings such as a warehouse, school, shipyard and saw mill has been used to make furniture. In one unique case outdated heirloom furniture made of wood now on the endangered species list was taken apart, milled and re-glued into a contemporary look. In another case, clients were about to discard all their first growth Douglas Fir door frames. Nicospacecraft salvaged and stored them for the right project to come along.

Closed loop: with the exception of plastic packaging and five to six gallons a year of lacquer thinner which are returned to local recycling facilities, the company has a closed loop production process. The company reuses as much of the plastic packaging as it can in its own processes.

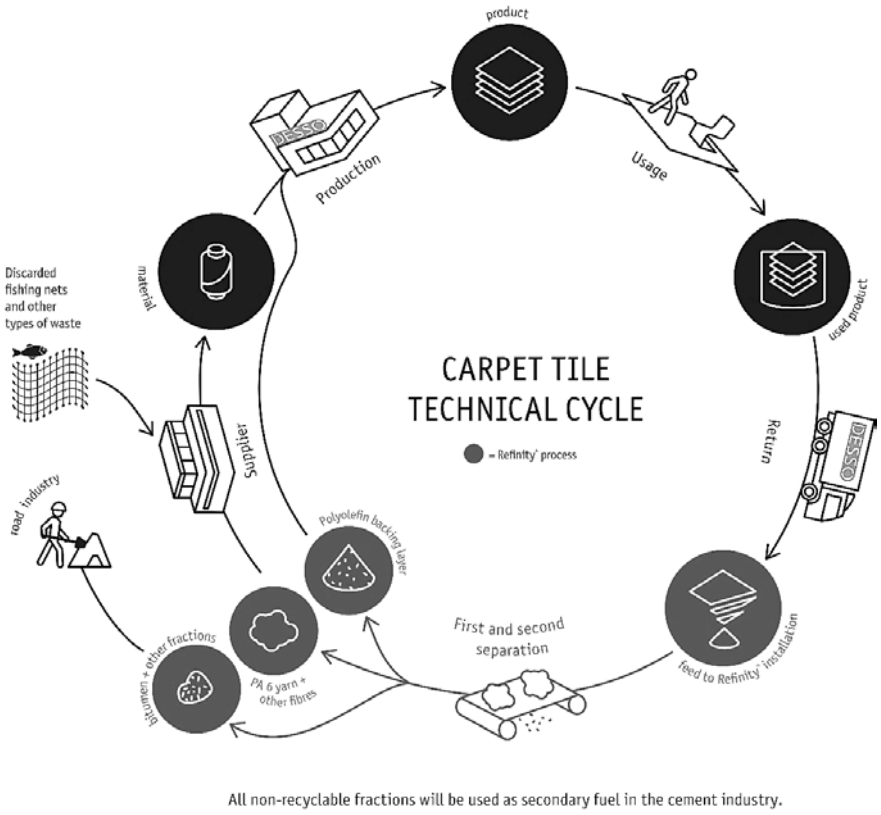
Circular supply models: Cradle-to-Cradle® at Tarkett

Tarkett is a leading manufacturer floor covering solutions operating globally around the world. Desso, a Tarkett brand for carpet tiles, provides high-quality carpets for commercial and domestic use, supplying inter alia the commercial, hospitality, maritime, and airline sector.

In 2008, prior to the acquisition by Tarkett, Desso launched a corporate strategy based on circularity principles which led to a Cradle-to-Cradle® gold level certification in 2015. In order to obtain a Cradle-to-Cradle® certification, the use of circular supplies is only the first step. Beyond material health and material reutilisation, there are also high standards with regards to renewable energy and carbon management, as well as, water stewardship and social fairness.

Desso is currently about to close its value chain completely. Milestones on this journey were its recyclable carpet tile backing called EcoBase™, its ReStart® collection program of old carpets, its Refinity® process , a recycling process which separates the yarn and other fibres from the backing, currently being re-built to process the post-consumer materials more efficiently. Desso is using recycled yarn known as ECONYL® as an input material for new carpets. Desso Cradle to Cradle Gold certified EcoBase™ backing is fully recyclable in Desso own production facility. The figure below depicts an illustration of Desso's technical cycle.

Figure A.1. The Desso technical cycle



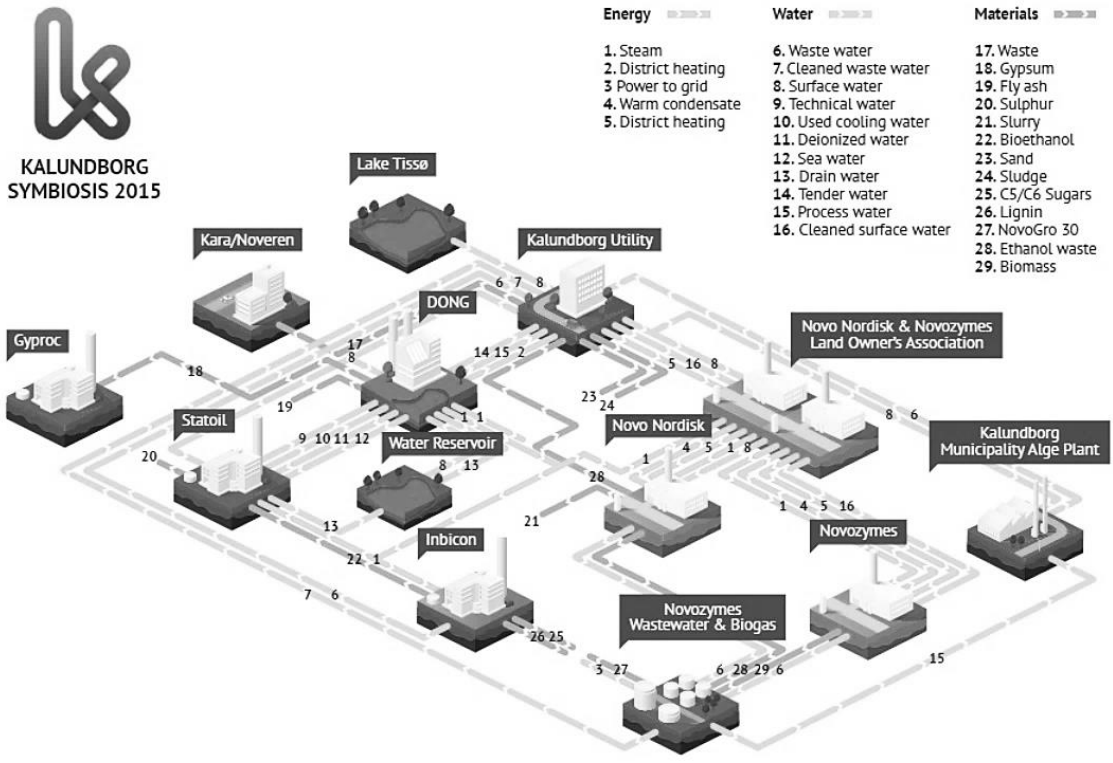
Source: EPEA (2017[2]), *EPEA – the Cradle of Cradle to Cradle,* https://bit.ly/2xk60LD

Resource recovery models: Industrial Symbiosis in Denmark

The Kalundborg Symbiosis industrial park is located 100km west from the Danish capital Copenhagen. It is perhaps one of the best-known examples for successfully putting the industrial symbiosis concept into practice. As a complete closed-loop industrial ecosystem it enables firms to directly sell materials, water, and energy to each other. This

does not only reduce waste and pollution, it also saves money and generates additional income for the participating firms. See also the figure below for an illustration of the Kalundborg Symbiosis site.

Figure A.2. The Kalundborg Symbiosis Industrial Park



Source: Kalundborg Symbiosis (2018[3]), *Kalundborg Symbiosis Industrial Park,* https://bit.ly/2wCqsJI

The eco-industrial park's dense web of pipelines and symbiotic relationships between firms of different industries has gradually developed over time. The earliest cooperation between the municipality of Kalundborg and Statoil's (former Esso) in 1961 marked the starting point for this large-scale industrial experiment. The current park still features the local municipality together with eight other companies. Among them are the world's biggest insulin producer (Novo Nordisk), the world's biggest enzyme producer (Novozymes), the largest water treatment plant in Northern Europe (Kalundborg Forsyning), and the world's first bio-ethanol demonstration facility (Dong Energy).

In terms of the environmental benefits, Kalundborg Symbiosis manages to achieve significant resource savings for its participating entities. The table below lists a number of key resources and emission that can be avoided each year, such as water, biomass, and air pollutants.

Table A.1. Annual environmental benefits of Kalundborg Symbiosis Industrial Park

Resource / emission flow	Annual savings
Ground water	2.9 million m^3
Surface water	1 million m^3
Liquid sulphur	20 000 tonnes
Biomass	319 000 m^3
Biomass (yeast slurry)	42 500 tonnes
CO2 emissions	64 460 tonnes
SO2 emissions	53 tonnes
Nox emissions	89 tonnes
Waste water	200 000 m^3
Gypsum	170 000 tonnes

Source: Domenech and Davies (2011[4]), *Structure and morphology of industrial symbiosis networks: The case of Kalundborg,* https://bit.ly/2QIHgVx

Resource recovery models: upcycling at FREITAG

FREITAG is a Swiss manufacturer of bags, accessories, and clothing founded in 1993 by Markus and Daniel Freitag. The company produces its bags from used truck tarpaulins, car safety belts, and old bicycle inner tubes. By upcycling these materials, new value is created from what would otherwise be discarded waste. FREITAG has gained considerable scale in recent decades, each year around 400 000 products are produced out of 460 tons of truck tarps, 130 000 car seatbelts, and 12 000 bicycle inner tubes (FREITAG, 2018[5]).

Product life extension models: remanufacturing at Caterpillar

Caterpillar is the world industry leader of construction and mining equipment, diesel and natural gas engines, industrial gas turbines and diesel electric locomotives. Its brand "Cat® Reman" sells exclusively remanufactured products and is currently employing around 4 000 people in 17 locations worldwide (Lacy and Rutqvist, 2015[6]). In 2014, Caterpillar remanufactured more 2 million components with associated material savings of 75 400 tons (Waste Management World, 2016[7]).

As a manufacturer of capital intensive machinery, remanufacturing makes sense from a business perspective: Around 65% of its operating expenses are already material-related (Ellen Macarthur Foundation, 2016[8]). Caterpillar then sells its remanufactured products at a discount compared to new ones, but with an identical warranty. Still, it is more profitable to sell a remanufactured product than a brand new one, in particular when it is leased out. Then gross profits can be up to 2.75 times higher than selling original equipment (Lacy and Rutqvist, 2015[6]).

Remanufacturing at Caterpillar is also desirable from an environmental perspective. Around 86% less energy is consumed during remanufacturing compared to producing a new product from virgin material. Remanufacturing a cylinder head, for example, uses 86% less energy, 93% less water, and emits 61% less GHGs (Snodgress, 2012[9]).

Sharing models: sharing at the Toronto Tool Library (from the National Zero Waste Council (2015[1]))

Toronto Tool Library is a non-profit social enterprise that lends specialized tools to community members. The Tool Library's members borrow tools in the same way they would borrow a library book. The Tool Library has over 3 000 tools available for loan including home repair, construction and renovation, gardening and landscaping, and bicycle repair tools. The tools range from simple screw drivers and drills, to table saws, welding equipment, power generators. Four 3-D printers and a laser cutter are available for use onsite. The library is a money- and space-saving alternative to ownership. Tool sharing reduces consumption and waste. The philosophy of the library – and what sets it apart as a social enterprise – is that it is not trying to maximize profit but trying to maximize membership and access.

In early 2013, Toronto Tool Library posted a call for tool and financial donations on the internet and through the local media. The request went viral and the Library received over 1 000 tools. Subsequently, the library was able to build its inventory primarily through donations. The donated tools not only created a community asset, but put unused goods back in circulation and kept them out of the landfill. The Tool Library secured space for their first location in the basement of a recreation centre. About 100 volunteers participated in the initial renovations to convert a basement storage space into a community hub for sharing tools. The Tool Library also received USD 8 000 in donations to cover renovation costs. For inventory and membership management they used MyTurn's tool lending library software which was available for free. The business community also provided start-up support. For example, Canadian Tire and The Mibro Group donated tools and the local Salvation Army offered $5 thrift store discounts to tool donors.

The Tool Library has incubated other circular economy sharing services, from a kitchen library to a repair café and swapping. These help foster public acceptance of the sharing concept.

The Kitchen Library lends expensive and rarely used kitchen appliances to its members, and offers cooking and baking workshops. It operated out of the Tool Library's premises in its first year before relocating to space closer to high-density living, a move expected to enhance its viability.

The Repair Café is a monthly event held in partnership with several community groups such as the Toronto Public Library in which people bring and repair their broken appliances. By repairing rather than discarding broken appliances, participants extend the life of their goods, reduce further consumption and landfill waste and save money.

To further reduce consumption and waste, and promote its sharing philosophy, the Tool Library runs swapping events, such as an Alternative Christmas gift fair in which people bring and swap lightly used or new items considered giftable. Similar events are held for other high consumption holidays such as Halloween and Valentines – shifting the public norm from buying to swapping.

Sharing models: sharing at Peerby

Sharing models have become increasingly popular in recent years. One major catalyst for this development was the last financial and economic crisis starting in 2007 which led to higher unemployment rates and less purchasing power, especially among young people. In this changed context, it became more attractive to share existing goods rather than buying brand new ones. Other factors that have contributed to the rise of peer-to-peer renting communities are lower entry barriers for creating and hosting online platforms, as well as a cultural shift in consumer mentality towards more sustainability (EPRS, 2016[10]).

Durable household goods are underutilised assets that can be shared relatively easy. The Dutch platform Peerby started in 2012, specializing in these kinds of transactions between peers. Since then they have expended from their home market in the Netherlands to Belgium, France, Germany, and the US. More than 15 000 members are participating in the network either via the desktop version on their computer or via the mobile app (TechCrunch, 2013[11]). An advantage compared to similar platforms of this kind is that borrowers do not have to actively search for someone in the network who owns that item. Instead a borrowing request will be pushed to 100 people in close proximity. This way, 80% of all requests are apparently fulfilled within 30 minutes of their posting. Peer-review and rating systems ensure that the community remains highly quality and responsive.

Peerby is completely free for its members, while receiving funding support from the DOEN Foundation, Clinton Foundation, and Sanoma Media (Lacy and Rutqvist, 2015[6]). At the same time, the platform is testing several premium options for members, such as subscription plans for high-value item and opt-in insurances.

Product Service System models: light as a service at Philips

Philips started to experiment with the ESCO business model after being approached by one of its clients, the German architect Thomas Rau. Both sides agreed on a specific outcome: an exact level of brightness for Mr Rau's architect's office in Amsterdam. It was left to Philips how to achieve this goal with the most cost-effective solution. Philips would also retain ownership of its lighting equipment, being in charge of the installation, maintenance, upgrades, and end-of-life recovery. By applying the newest lighting technology – light-emitting diode (LED) lights – Philips was able to cut the energy costs of the architect's office by 35%.

After this successful project, Philips then reached out to public clients and approached the city of Washington, DC. The company offered to replace over 13 000 light fixtures in the city's parking garage with LED lights at no cost to the city. Only afterwards, Philips would earn money as a portion of the projected energy savings. The replacement was forecasted to reduce the energy usage by 68% or 15 million kWatt hours per year, resulting in $2 million in annual savings. It was estimated that these savings will remove over 11 000 metric tons of CO2 from the environment which is equivalent to removing over 2 300 cars from the road (Lacy and Rutqvist, 2015[6]; Philips, 2013[12])

The case of Philips shows that there are large environmental and economic benefits from upgrading existing lighting infrastructures. The global potential of this practice can be further illustrated by referring to the *Enlighten Initiative* which is a public/private partnership between the United Nations Environment Program, OSRAM, and Philips

Lighting, with the support of the Global Environment Facility. The website states that the share of electricity used for lighting accounts for around 15% of global energy consumption and for 5% of global greenhouse gas emissions. By switching to efficient on-grid and off-grid solutions, more than $140 billion could be saved every year, reducing CO2 emissions by 580 million tons annually (U4E, 2018[13]).

Product Service System models: access to rather than ownership of garments at Rent Frock Repeat (from the National Zero Waste Council (2015[1]))

Rent frock repeat is a Toronto-based online dress rental service that ships across Canada via Canada Post. The company offers members designer dress rentals through its e-commerce site as an alternative to purchasing expensive dresses that are rarely used. The company shops for the best designer dresses from around the world, visiting top fashion shows and showrooms, and then makes the dresses available for a fraction of the retail price. Customers save time, money and space and look fabulous at their events.

Technology makes the business possible and attention to their customers' needs make it popular. Over 57 000 on-line users browse the company's website for the perfect dress for their big night out. To help customers find the perfect dress on-line the company includes styling tips for a variety of occasions and body types. They have all sizes from 0-24 and customers can rent a second size for only $10 to ensure fit. Members also have access to private fitting appointments in the Toronto and Ottawa areas, private parties and phone or Skype consultations.

The business model has really struck a chord with customers and investors. Rent frock Repeat raised $1.15 million from two Ottawa-based angel investors in November 2014. A wise investment when you consider that it is estimated that 40% of Canadians are sharers and predict that the Sharing Economy is expected to double in the next year; Companies that embrace sharing will win loyal customer and increase market share. The angel investor funding allows Rent Frock Repeat to respond the growing popularity of dress rentals in Canada by opening up new storefronts. RfR is scheduled to open its Ottawa store in summer 2015 and plans to open a store in Calgary as well.

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