Facility Management in a Circular Economy

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Circle Economy
Make it happen from start to start

AAFM Value Enablers

November, 2014
About this document

This document has been produced for AA-FM as part of the 2014 membership with Circle Economy. Within this document, we aim to provide a general overview of the role of facility management within a circular economy, and discuss some of the key impact areas that can be addressed at this level. We will also dive into specific examples of how AA-FM can begin to realize a transition toward circularity.

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The City of Edinburgh Council building

The City of Edinburgh Council’s vision ‘to be the most successful and sustainable city region in Northern Europe by 2015’ was embodied in the design of the council building. The design incorporates maximum sustainable content in every aspect of the project. In tandem with this imperative was the requirement to achieve the Council’s other key objective which was to build an open and transparent change culture to incorporate the most progressive work practices.
1. OVERVIEW OF A CIRCULAR ECONOMY

1.1 Background

The term “circular economy” has become a buzzword in policy and business circles ever since its use in the first joint report published by the Ellen MacArthur Foundation (EMF) and McKinsey and Company in 2011.

The EMF-McKinsey report presented an inspiring landscape of opportunity that could be gained by moving towards a Circular Economy, which is broadly defined as an economy that is regenerative and waste-free by design. This rhetoric appealed to the business community in particular by focusing on the vast potential for financial gains that can theoretically be achieved by reusing all raw materials that are currently disposed of in the linear “take, make, dispose” system and by extending the value-generating life cycle of products.

Part of the appeal of the Circular Economy is a clear focus on material cycling. Unlike the term ‘sustainability’ which casts a broad net over many issues, a focus on materials makes it seem inherently easier to tackle. Another appeal of the Circular Economy story is that whereas not all aspects of sustainability seem to provide clear pathways for profitability, the Circular Economy approach seems to be broadly and directly translatable to cost-saving measures (savings on raw materials, greater profit margins on service-oriented business models).

1.2 Principles of a circular economy

Circle Economy is all about changing systems. Thinking, producing, funding, selling, consuming, rewarding, sharing, etc. It all can change for the better. From linear to circular. From old to new. From me to we. Here are the six guiding principles we use to make it happen:

- All materials are cycled infinitely in either technical or biological cycles
- All energy is derived from renewable or otherwise sustainable sources
- Human activities support ecosystems and the rebuilding of natural capital
- Human activities support a healthy and cohesive society and culture
- Human activities support human health and happiness
- Resources are used to generate value (financial and other forms)

1.3 Overview of Circle Economy

Circle Economy is a nonprofit cooperative, based in the Netherlands, aimed to accelerate the transition to a circular economy. We are a membership-based organization, and our members include large multinational companies, SME companies, research institutions and innovative startups. All members are required to work together and with our organization on identifying and implementing circular projects. Our team uses a systems thinking approach to identify circular opportunities and bring together partners to implement.

Active areas, themes of work

Circle Economy is active in many areas through its member projects. There are several topic areas that emerge in importance, considering the impact of the sector, number of members involved in the topic area, and level of innovation and entrepreneurialism. In 2014, Circle Economy is focusing on a number of key areas including:

- Textiles
- Agriculture and food
- Design
- Finance
- Mobility
- Electronics
2. FACILITY MANAGEMENT IN A CIRCULAR ECONOMY

2.1 The Role of Facility Management

Facility management in the basic sense involves the coordination of space, infrastructure, people, and administration for organisations. From the perspective of a circular economy, facility managers organize and control the physical resources that flow through a location, as well as the programmatic services for the people who work within the facility.

When looking at the life cycle of a commercial building, the vast majority of resource consumption and impacts to the environment occur during the "use phase" - the overall time when the building is being used by one, or many parties. The majority of these impacts come from the provision of daily services to users, such as the electricity to light and power equipment, ventilation and heating, and the consumption of material resources like food, water, and office supplies. In addition to the resource use within the building, it is also important to look at how people and resources travel to and from the building, and the impacts associated with these movements.

Approximately 7% of GHG emissions in the Netherlands come from commercial buildings. The effects from localized emissions create heat islands, which contribute to 5-10% of peak energy demand in the summer months.

About 8% of national energy demand goes to treating, pumping, and heating water. 30% of a building’s water is used outdoors in landscaping. Despite available land, most facilities do not optimally cascade or treat water on site.

On average, we spend about 90% of our time indoors, and our workplace is an important factor in our physical and mental health. The annual societal costs related to workplace stress and repetitive strain injury amounts to €6 billion. Absenteeism in the Netherlands is 7.6 days/year, costing employers approximately €10.8 billion.

Together, building construction, renovation, use, and demolition constitute roughly two-thirds of all non-industrial solid waste generation. Because architects do not typically design for easy renovation, deconstruction, or efficient use, a lot of material resource value is lost.
2.2 Impacts of Facility Management

Facility managers are in the unique position of overseeing this system, and have a high level of control and influence in reducing the impacts associated with the activities within the use phase.

Looking at the typical service areas of facility management, we can see that there are a variety of important impacts. While these impacts differ per building, in this section we will take a closer look at each category and compare the impacts in the use phase compared to the construction phase. This will give us a basic sense of the magnitude of these impacts.

To highlight the differences in energy use in the use phase versus the construction phase, let’s take an example office space of 5,000 m².

### Total stock of commercial buildings;

There are a total of 48-50 million square meters of commercial office space in the Netherlands, of which 12-18% is vacant. (1) This does not include industrial or retail facilities, which also constitute commercial real estate.

### Average lifespan;

While each building differs, the average lifespan of a commercial building is approximately 50 years. The cycle for refurbishment is approximately every 10 years, and renovation between 20 and 30 years.

### Energy consumption;

If we assume a total stock of office space of 50 million m² in the Netherlands, the total energy consumed in the use phase is approximately 61.2 billion MJ. Of that, approximately 60% is used for heating.

- **Heat:** 35.850.000.000 MJ
- **Electricity:** 25.300.000.000 MJ

In a typical building, heating, ventilation, and cooling (HVAC) is the single largest source of energy consumption. In the Netherlands, heating is mostly supplied by natural gas, however cooling is supplied through electric ventilation. In addition to HVAC, lighting and the powering of electronic

### 1. Heat consumption

<table>
<thead>
<tr>
<th>Phase</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>2.0 million MJ</td>
</tr>
<tr>
<td>Use</td>
<td>89 million MJ</td>
</tr>
</tbody>
</table>

### 2. Electricity consumption

<table>
<thead>
<tr>
<th>Phase</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>0.5 - 1.0 million MJ</td>
</tr>
<tr>
<td>Use</td>
<td>90 million MJ</td>
</tr>
</tbody>
</table>

### 3. Water consumption

<table>
<thead>
<tr>
<th>Phase</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>36 million L</td>
</tr>
<tr>
<td>Use</td>
<td>72 million L</td>
</tr>
</tbody>
</table>

### 4. Emissions

<table>
<thead>
<tr>
<th>Phase</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>10,000 kg CO₂ eq</td>
</tr>
<tr>
<td>Use</td>
<td>472 million kg CO₂ eq</td>
</tr>
</tbody>
</table>

### 5. Material consumption and waste

<table>
<thead>
<tr>
<th>Phase</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>120,000 kg</td>
</tr>
<tr>
<td>Use</td>
<td>2.25 million kg</td>
</tr>
</tbody>
</table>
equipment are often the second and third largest sources of consumption, respectively.

**Water consumption and emission:**
The total consumption of water from commercial buildings in the Netherlands totals 88 million litres. The source of this water is the municipal drinking water supply.

Within the building, the largest sources of consumption are toilets (52%), and water use in the kitchen (46%). The remaining 2% come from a variety of other sources such as cleaning.

Waste water is emitted in two categories, grey and black water. Grey water refers to the relatively clean waste water from baths, sinks, washing machines, and other kitchen appliances. Black water refers to the waste water and sewage from toilets. Both of these streams are combined in the sewer system and collected by the municipal waste water company to be processed and cleaned. Total waste water collected from commercial buildings in the Netherlands is approximately 88 million litres, of which:

- Grey water: 42 million litres
- Black water: 46 million litres

To highlight the differences in water use in the use phase versus the construction phase, let’s take an example office space of 5,000 m².

**Emissions:**
The total emissions from the built environment is significant. Nationally, about 166 billion kg CO₂-eq is emitted every year, of which 130 billion tons (78%) originates from the built environment.

Using our example building of 5,000 m², we can see that emissions during the use phase far exceeds the emissions during the construction phase.

### 2.3 Exploring key leverage points in the system

Facility management is under continuous pressure to innovate in cost reduction and new value creation to the core business of companies. There are many opportunities whereby increasing the level of circularity of resource flows during a building’s use can both reduce overall operational costs, and create new value streams for client organisations.

If we look at the leverage points in the system that can really influence the use phase, both in terms of impact reduction and new value opportunities, we can see that there are several clear areas of intervention that can be focused on. These interventions fall under three broad categories that we will explore further in this section;

- **Working in a broader way with stakeholders in the design phase;**
- **Use phase interventions;**
- **Facilitating behavioural change and usage patterns during the use phase.**

**Working broadly with stakeholders in the design phase**

One of the largest leverage points in the system to explore is Developing an integrated role in the design phase, along with Architects, planners, and other stakeholders.

- **Work with architects in the design stage as much as possible:** Work to make the building adaptable and upgradable to different functions, during the use phase (also design for Passivhaus standards). Make it easier to access internal infrastructure such as wiring and ventilation. It has been estimated that British businesses currently spend over £2 billion a year on moving people or departments around office buildings in response to organizational change. This is exclusively unproductive overhead expenditure, and working to reduce it will improve the competitiveness and profitability.

- **Promote Passivhaus standards:** Guidelines for building to limit demand for space heating and lighting by maximizing solar energy...
potential by orientation of the building and placement, arrangement and size of windows and the use of heat recovery ventilation systems. If fully utilized could result in up to a 90% reduction in energy demand for a building. (see example).

- **BIM (Building Information Modeling);** 3D model based process for planning, designing, building and managing a building. Allows for easy collaboration between different professionals working at different stages of a building’s lifecycle. During the management phase, BIM makes available current information on the building’s performance and use, its occupants and contents, and financial aspects in terms of renovations and maintenance.

- **Parametric Building Modeling Technology;** spreadsheet like database for buildings. Database is integrated and all of the information is parametric and interconnected. Allows multiple users to make changes, and those changes are reflected in the other relevant parts of the database immediately. Integrated with BIM.

- **Optimize design for the total cost of ownership;** Typically, the cost of repair alone is five to 15 times more than the cost of the effort that would have prevented the failure. Better planning, forecasting, speed and quality of delivery of maintenance projects due to easy to upgrade hardware (design) and close collaboration with and commitment from contracted parties (long term contracts). Potential savings TCO: 10-20%.

- **Building for correct life-span.** Most buildings are designed to have a 50-year life-span. However, due to rapidly improving technology this life-span is usually much shorter. Old buildings just do not have the available floor space or technological capabilities to meet the needs of evolving office culture. This leads to a boom in new building while old buildings are left vacant and underutilized well before their expiration date. (see footnote) New buildings should be conceptualized for a shorter life-span that would correspond with the rate of technological innovation and be designed and built in a flexible way to allow for an easy conversion to new use or the installation of modern technologies.

**Use Phase Interventions**

Facility managers are in the unique position to orchestrate how materials and resources flow through the facility and surrounding areas. There are a number of opportunities to intervene with physical technologies or programmes that help circularize the flow of these resources, and extract new forms of value for users of the building.

- **Energy reduction programs;** Many interventions can be made to help curb the overall energy use in a building. Many of these programs have been successful by incentivizing continuous improvement, and taking ownership over impacts.
  - Promote green transport with users through behavioral incentives
  - Decentral adjustment of heating and lighting • Incorporate sensors and user interfaces for feedback systems
  - “smart building” monitoring that gives users feedback on their resource use can reduce energy demand by 15 - 30%.
  - Employees like to feel involved in decisions and often hold the most practical ‘on the ground’ knowledge of processes. Encourage involvement and you will not only raise morale but allow them to identify possible gains

- **Waste reduction programs;** Waste collection organisations indicate that source separation is the most important step to deriving maximum value of waste materials. A large scope of improvement can be made by providing the infrastructure and education on the importance of source separation of waste.
  - Use of local digestors and other clean technologies to valorize (organic) waste streams, including black and yellow water.
  - Storm/ rainwater collection (and local re-use) a.o. through green roofs.
  - Bees/ birds/ other animal friendly measures (e.g. create niches for animal and plant life in building design).
• **Monitoring and Continuous Improvement:** Monitoring technology and improvement programs are an effective way of striving for continuous improvement in consumption over the use phase. Already, technologies like smart metering are widespread, and represent an important element in optimizing the overall performance of energy use in a building. Some other interventions include:
  - “Smart building” – making sure the data that is being monitored is transparent and easily accessed so employees can judge their own performance. “Smart building” monitoring that gives users feedback on their resource use can reduce energy demand by 15 - 30%.
  - **BIM** – process to monitor a building’s health throughout its lifecycle.
  - Real-time monitoring of equipment and operations performance is especially relevant in facilities that combine traditional office functions with production or processing functions.
  - **Closing loops on-site:** Most materials move through a building in a linear way, however there are undoubtedly interesting possibilities to divert some of this throughput by developing solutions to manage materials on-site, or through partnerships with other local organizations.
    - The organic waste stream is one of the more interesting areas of focus, as it typically makes up 20-30% of total waste by volume. There are many avenues to explore here, including biogestion, heat recovery, mineral extraction, and compost as input for on-site food production or general soil amendment. Having food production on-site can also provide other benefits, such as employee engagement and education, through the provision of green, outdoor spaces.
    - Cascading water in more appropriate ways, in respect to water quality can also provide big reductions in overall water use. Grey water can be collected and used on-site for toilets. Grey water can also be cleaned on the building’s premises, and integrated into the landscaping design.
    - Heating and cooling are by far the largest energetic demands for almost any building. Thinking beyond insulation and building orientation, there are possibilities for active heat recovery. Examples of this include geothermal heat pumps, as well as extracting heat from waste water or cooking. Both of these methods can reduce the overall operations costs significantly over the whole year.
    - many facilities sit on land that requires landscaping and maintenance. We mentioned that compost can be used as an input into landscaping maintenance, however landscaping design can also look very different. Many urban areas are devoid of native flora and fauna, and urban landscape design can play an important role in strengthening local ecosystems and species.
    - One of the central tenets of a circular economy is to use renewable energy sources exclusively. Integrating renewable energy technologies in buildings has become much more widespread in recent years. Depending on the unique needs of a facility, there are many interesting ‘cleantech’ solutions that can provide solutions such as combined PV and solar hot water, small-scale biogestion, and electricity storage via batteries for emergency back-up power.
  - The sorting and pre-processing of waste on-site is one of the best ways to ensure a maximum amount of recycled materials. Integrating adequate infrastructure and education on the importance of separation is an important step in reducing material waste. In addition to pre-sorting, investigations can be made to whether industrial waste streams can potentially be reused by local organisations, known as industrial symbiosis.
  - While maintenance and repair already exist as a central part of facility management, the emergence of 3D printing technology make on-site (re)manufacturing an interesting option for further exploration. Such capacities could highly reduce the need for ordering in special parts, labour, or new equipment.
**Behavioural change**

Since facility management is involved with so many daily services, there is a large leverage point in behavioural change to explore. Facilitating behavioural change in users can be approached in programs and education, monitoring and feedback, and incentivizing efficiency.

**Wellbeing and Work**; The way people are working is changing. Today, Europe’s mobile workforce amounted to approximately 130 million individuals, accounting for roughly 50% of the total workforce. This number is only expected to grow in the future. Co-working trends and shrinking office space demand Companies are striving to use real estate more efficiently to get an immediate bottom line impact. Organizations are also utilizing space differently to accommodate changing work patterns, such as mobile working and flexible work hours. The availability of co-working spaces increased around the globe by 245% in 2012.

Catering to the needs of a more mobile workforce, and facilitating optimal wellbeing and productivity are key services in facility management. Here are an overview of some innovations in this field:

- Include access to additional (local) services like laundry, hairdresser, babysitter, etc. This makes the office a ‘one-stop-shop’ and can offer a wide range of functionality to mobile workers.
- Decentralized adjustment of heating and lighting. Allowing people to control their environments has been shown to improve overall productivity, and gives people control over their own space.
- Natural ventilation and easy access to green spaces has also been strongly linked to indoor air health, and individual wellbeing. Green spaces are also important in the alleviation of many kinds of stress, and have been shown to improve productivity up to 11%.
- Optimization of acoustics, and designing for appropriate workspaces are important elements in a flexible office. Quiet and private spaces offer a reprieve from noisier shared spaces, and allow employees the possibility to customize their work environment at nearly anytime.
- Designing buildings such that workers receive good natural lighting and views to the outside have shown to improve productivity up to 23%. Having control over opening windows has also been shown to be an important factor in overall wellbeing, increasing productivity by 18%.
- A warm greeting for a new employee turns out to have a big impact. According to Bock, a manager greeting a new employee with ‘Hi nice to meet you, you’re on my team, we’re gonna be working together’ and doing “a few other things” leads to a 15% increase in productivity over the following nine months.
- Engaging employees to work towards collective goals, and incentivizing personal performance have shown to be an important element in overall culture, and environmental performance. We have already discussed the ideas of programs for energy use, source reduction and separation of waste, and incorporating sensors and user interfaces for instant feedback.
- Designing for function is also an important area where facility managers can influence use phase performance. For example, choosing not only highly efficient appliances, but also configuration and how the use of appliances is encouraged or discouraged (e.g., designing lighting to focus more on work areas directly rather than ambient lighting - can save a huge amount of electricity over time).
- Behavioral incentives can also have a positive spill-over effect to the rest of worker’s lives. The promotion of green transport such as cycling, public transport, or electric vehicles can be an effective way of helping behavioural change spread outside of the office. In the case of cycling, offering workers with covered parking, repair facilities, and shower and changing rooms can provide additional value for new cyclists who usually travel by car.

3. TAKING STEPS TOWARD CIRCULARITY

Circle Economy works with many members who are actively exploring how best to transition to a more circular state of affairs. While our work with members varies across many subject areas, the theme of buildings and how they are used is a common area explored with other members. In this section, we will share some of the directions that are now being undertaken by our other members, and highlight links where AA-FM could potentially explore further.

3.1 Property development and buildings

The built environment is one of the largest contributors to environmental impact and resource consumption globally. We are currently working with members on the subject of circular buildings, and particularly how to tackle practical issues such as design and reuse, and more abstract issues such as legal frameworks and insurance policies.

OVG:

OVG is a real estate developer based in Rotterdam. We have worked with OVG in envisioning what a truly circular building might look like, and what kind of leadership role a developer could have over the lifecycle of such a building.

In addition to our work with OVG, we have worked with Rabobank and ABN Amro on the topic of transitioning the construction and demolition sector toward a more circular state. Much of our work here has involved understanding the main leverage points in the sector, and stimulating stakeholders in the sector to commit to practical steps in realizing such a goal.

A map showing the inputs and outputs of a building in a circular state. Annotated in blue are some of the key intervention areas that would need to be incorporated into a circular building.
3.2 Appliances and interior

A large focus within the built environment are the consumer products and appliances that fill homes and offices. We have been working with a number of organisations to better understand how these products themselves can work in a circular system. Most of our work so far has focused on how the embedded services within products can deliver new value to consumers, without bearing the impacts associated with disposal.

**Philips:**
Philips is one of the world’s largest electronics manufacturers in the world, and we have been working with them to investigate how exactly a service-based model to products (i.e. product leasing) could work for them. We have worked on the topic of lighting (indoor and outdoor), home appliances, and medical equipment.

**Desso and Interface:**
Desso and Interface are both carpet manufacturers who are already have a deep understanding of sustainability in their product lines. Our work with these companies includes a much deeper analysis of how products can be designed in such a way that they are 100% recoverable at the end of their use.

A simple overview of a home in terms of its energetic input, and where that energy is consumed, by which products. At the end of a products life, we can also see an ‘ideal’ loop where they are collected and either repaired or remanufactured.
3.3 Waste management

Van Gansewinkel:
Van Gansewinkel is one of the largest waste collection and processing companies in the Netherlands. In our work, we have focused on the broad topic of valorization of waste streams, specifically on textiles. Van Gansewinkel is currently active in the topic of circular economy, and now operates a “Circularity Centre” in Rotterdam.

Afval Energie Bedrijf:
The Afval Energie Bedrijf (AEB) is Amsterdam’s central waste incineration facility. Because the transformation of waste collection and processing is so critical in the shift toward a circular economy, we have worked with AEB to outline a future vision for waste collection in Amsterdam.

A look at the waste flows in Amsterdam, and how the Afval Energie Bedrijf is currently processing this waste.
3.4 Legal and Insurance

ASR:
We have worked with ASR to better understand how home insurance might work in a circular economy. In many instances, insurance companies act as brokerage agencies for damaged goods. Despite the fact that these goods are damaged, we have investigated alternative channels for resale and reuse that preserve the complexity and value of these materials.

Allen and Overy:
In a circular economy, one of the business models that is often explored is leasing. This model stems from the idea of ‘access over ownership’ and the idea that most of the products and goods that we use in our everyday lives can be used on an access-basis, and don’t necessarily need to be owned. Our work with Allen and Overy has centered around legal issues in leasing arrangements, and better understanding how companies can implement such models.

Company Z can demand that Company X insures Product Y with a.s.r. against the risk of break down or value destruction during the usage phase.