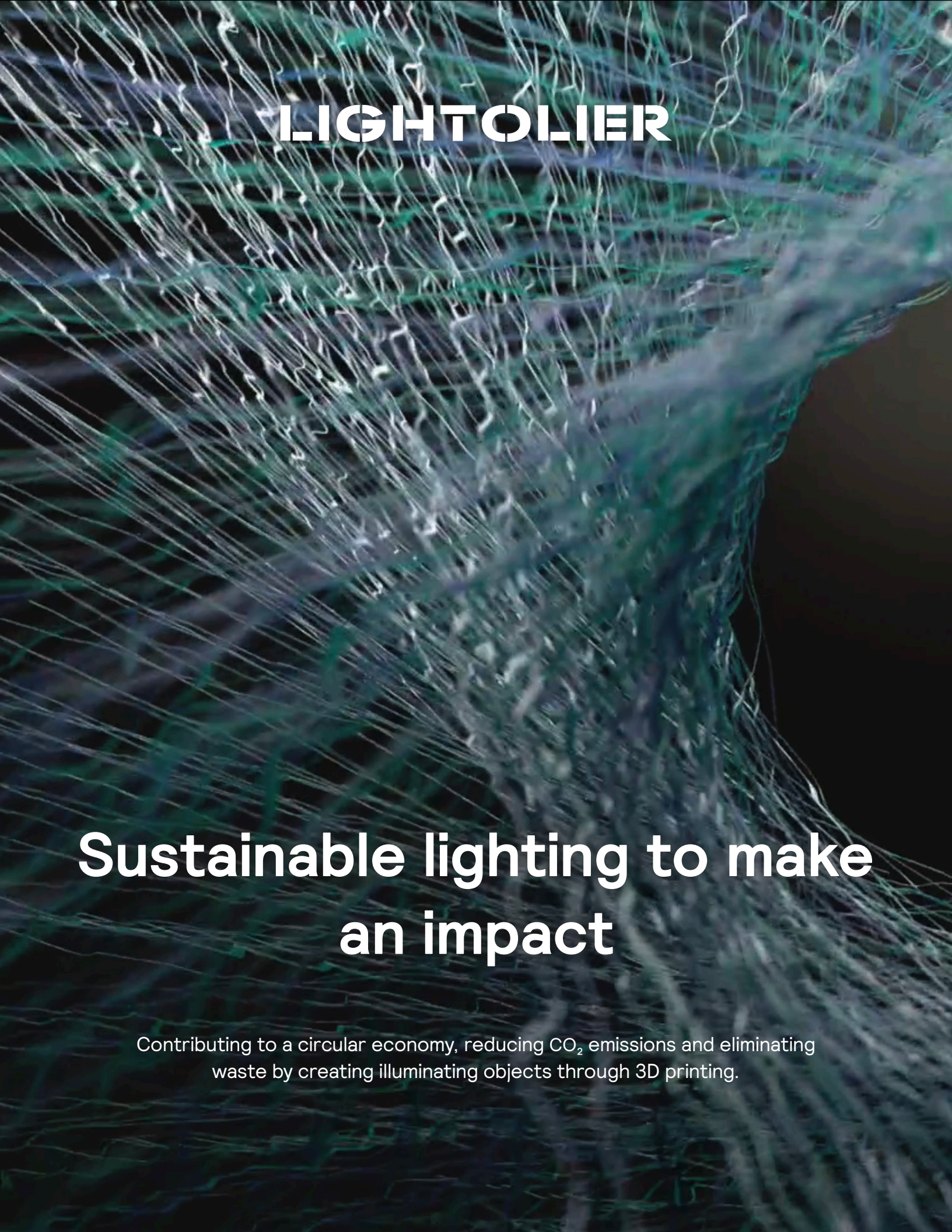


LIGHTOLIER

# Sustainable lighting to make an impact

Contributing to a circular economy, reducing $CO_2$ emissions and eliminating waste by creating illuminating objects through 3D printing.

# Index:

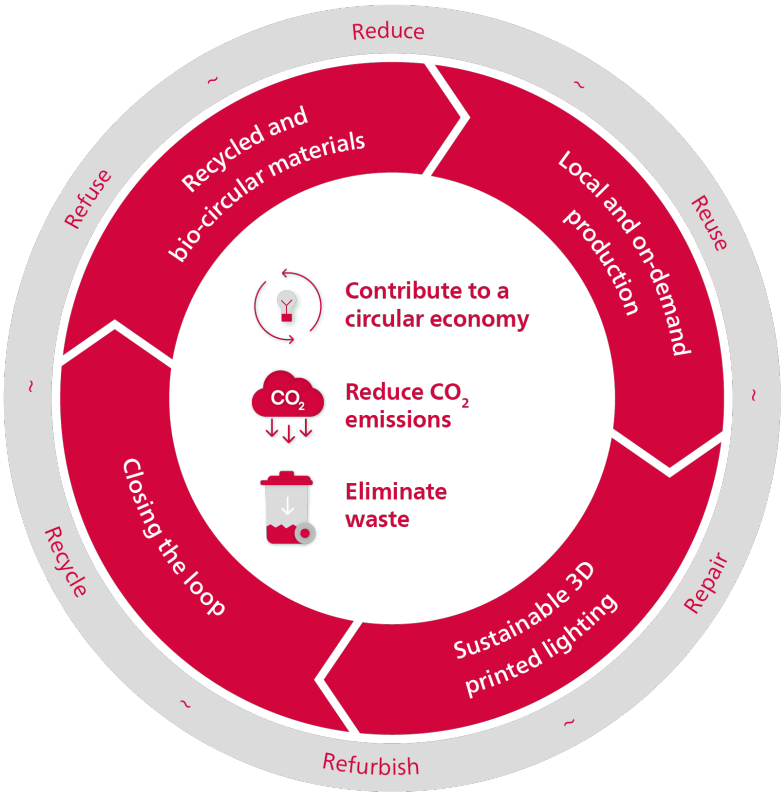
# Rethinking our production for a brighter future

Sustainability is by far one of the most important issues of our time. The fostering of long-term economic growth must not have a negative impact on other systems such as social or environmental. To achieve this goal, companies must address strategic and operational challenges.

## Sustainability as a matter of course

To remain competitive, successful and a leader, we at Signify are consistently working on the holistic transformation to a sustainable company. In addition to our operational commitments such as being committed to net zero and using 100% renewable electricity, we place great emphasis on the sustainability of our products – a matter of course for a leading global manufacturer.

Since the earth is known to have limited resources, we are obliged to work on transformation of material flows: from linear into circular, from finite into renewable, from virgin into recycled and bio-circular. In a circular economy, material consumption should be a circular process where renewable resources and waste streams are reduced, reused, repaired, refurbished and recycled.



## 3D printed luminaires as part of a circular economy

3D printing is a highly flexible, more sustainable form of manufacturing, in which luminaires can be made with raw material that has already been recycled, tailored to the customer's exact needs and recycled at the end of their life. In Signify's 3D printed luminaires, select components may be reused or recycled – thanks to a consistent disassembly concept – supporting the concept of a circular economy. They are printed only on demand, which enables a significant reduction in inventory – another important factor in terms of overall sustainability, just like the best possible avoidance of waste in production.

## 9 elements where 3D printing makes a sustainable difference

1. Using recycled and bio-circular materials which have a story to tell
2. Fewer components for more flexibility
3. The assembly with disassembly in mind
4. Closing the loop of recycling
5. Lowering carbon emissions in materials and transport
6. Reducing carbon emissions in production
7. Producing on demand instead of on stock
8. Zero waste production
9. Resulting in sustainable products

# Using recycled and bio-circular materials which have a story to tell

An essential component of ecological sustainability strategies is to move away from the use of virgin materials for the production of goods. Using fewer fossil resources – and more recycled and bio-circular sources instead – is an important step toward stopping global warming and preserving the earth's foundations of life. In particular, the consumption and processing of petroleum over the last 150 years have affected the climate in a highly damaging way. It has long been proven that a fundamental change urgently needs to happen.

## Revolutionary technology for a fundamental decision

Part of this change is behavioral, but an equally important part is technology. One of the technologies contributing to the urgently needed change is 3D printing. Today, it is even possible to build houses with appropriately sized 3D printers. The revolutionary concept and the rapidly developing technology of the last years represent a turning point in production contexts. The various reasons for the superiority of the 3D printing concept are given below. Before that, one decision is at the heart of sustainability thinking: moving away from virgin raw materials as feedstock.

The solution to this fundamental issue sounds simpler than it is in industrial reality: the transition to the exclusive use of mass-balanced bio-circular and post-consumer recycled material. The combination of these two sources will be required to meet the demand for sustainable raw materials. For its 3D-printed luminaires, Signify no longer uses virgin materials for the 3D printed parts but works with both eco-friendly materials mentioned above.

## Already working with 75% bio-circular printed parts

Bio-circular mass-balanced raw materials are materials from ISCC PLUS (International Sustainability and Carbon Certification) certified waste streams and residues. These can be tall oil from the wood processing industry or used cooking oil. The bio-circular granulate used as raw material for Signify's 3D-printed luminaires is ISCC PLUS certified and 89% renewable. Based on the colors and additives used in production alone, the officially mass-balanced rate will be at least 75%.

**GOOD TO KNOW: ISCC PLUS**
ISCC PLUS is a globally applicable sustainability certification system for fully traceable and deforestation-free supply chains.

## Post-consumer recycling (PCR)

Post-consumer recycled material refers to the recycling of used goods. Standard PCR content includes packaging material and plastic bottles. One of our pendant lights offers an outer shade made from 50% recycled water jug material. Inner shades are made from over 75% ISCC Plus certified bio-circular materials.

## Water jugs, recycled and reimagined

On our mission to produce lighting as sustainably as possible, we adopted plastic recycling processes and use post-consumer recycled materials. We are committed to using recycled components.

Crafted from a unique, sustainable material derived from 5-gallon water jugs, the Riverstone pendant boasts a light aqua hue reminiscent of gentle waters.

Designed for scalability, Riverstone can be showcased in clusters, as a standalone piece, or as part of a statement installation, adapting seamlessly to various space needs and design aesthetics.

By repurposing water jugs into a beautiful, durable material, we not only reduce waste but also hope to champion the cause of environmental stewardship.

# Fewer components for more flexibility

Apart from the issue of source material, additive manufacturing offers several advantages. One of these is the integration of multiple functions into a single component, e.g. the integration of the strain relief into the housing of a luminaire. In this way, two screws and a plastic part are typically removed from the assembly. This allows for easy and quick disassembly, as the strain relief does not need to be separated into one or more waste streams. Finally, one assembly step is taken out of the production process, which increases its efficiency. Where conventional production technology required two parts and a corresponding connection, a single part is now sufficient.

## The freedom to design colors, shapes and textures

Another advantage of 3D printing technology is its flexibility and design freedom. 3D-printing allows for an almost unlimited number of different component shapes - an impossibility with traditional manufacturing methods such as injection molding, which is always restricted by the mold release. With 3D-printed lighting there's no such limitation, so your customers get the design they want.

Traditional metal luminaire

Lightolier 3D printed luminaire

| | | |
|---|---|---|
| disassembly: | 8.5 minutes | 3 minutes |
| components: | 32 | 18 |
| color paints: | 2 | 0 |
| screws and washers: | 14 | 6 screws, 0 washers |
| material groups for recycling: | 9 | 5 pure material groups |

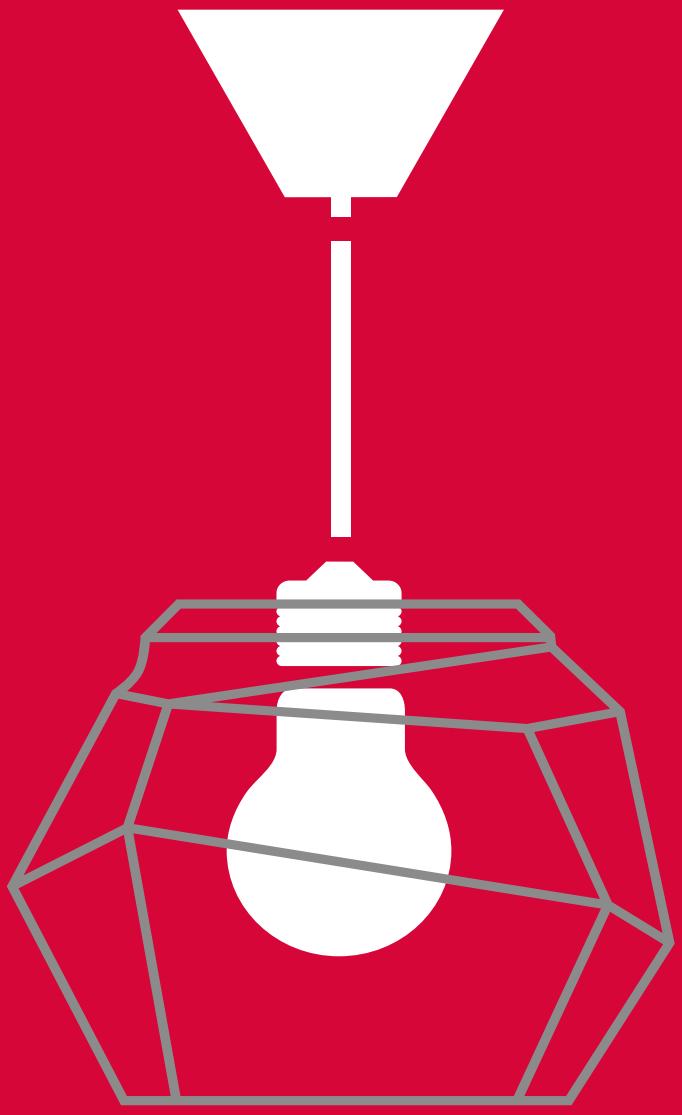
## Enabling human and environmental health

Genlyte has received five Declare certifications for its 3D printed products. Declare is a label to highlight healthy building products, awarded with the aim of enabling the creation of buildings that support human and environmental health. It is issued by the International Living Future Institute, a non-governmental organization committed to catalyzing a global transformation toward true sustainability.

# The assembly with disassembly in mind

When the life of a luminaire comes to an end and it is time to recycle it, it is important that disassembly is as simple as possible. A 3D printed luminaire consists not only of printed materials, but also of non-printable components such as LEDs, drivers (which in turn consist of electronic components) and metals (such as heat sinks and screws). In End-of-Life recycling, the various components need to be disassembled and sent to separate waste streams, where they can be appropriately recycled.

Another contribution to easy disassembly is the minimization of mechanical connections by glue or screws – by replacing them with click components. Design guidelines limit the use of glue, the number of screws and the number of fixed “one time” click connections. To effectively support End-of-Life recycling, each product is provided with disassembly instructions. This enables the recycler to easily separate the different parts and transfer them to the correct waste streams.



# Closing the loop of recycling

The collection and recycling of end-of-life electrical equipment protects the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste from electrical and electronic equipment. It also reduces the overall impacts of resource use and improves efficiency and contributes to sustainable development.

## Pilot projects to close the loop

Components such as glass and metals can be recycled easily, and the recycling rate is already quite high. With plastics, things are a bit more complex. There are many types of plastics, all with different properties, such as melting temperature. It is difficult to separate the different types of plastic when they are mixed. Polycarbonate is a high-quality plastic that can be recycled when kept separate.

In North America, Signify has forged a partnership with Colgate Paper/AIT, a well-recognized U.S.-based recycling company that specializes in disassembling end-of-life lighting products and repurposing components, particularly plastics, to create new products. This collaborative effort represents a significant stride in promoting an environmentally sustainable and circular economy. Signify's involvement not only reduces post-consumer waste but also contributes to the reduction of landfill and ocean pollution from discarded materials.

# Lowering carbon emissions in materials and transport

Research shows that reducing emissions from fossil fuel combustion and other sources results in better air quality – and it slows climate change by improving human health and preventing economic losses. A 2020 study compared the Life Cycle Assessment of a traditionally manufactured downlight with a die-cast aluminum housing and a 3D-printed downlight, both delivering the same amount of light.

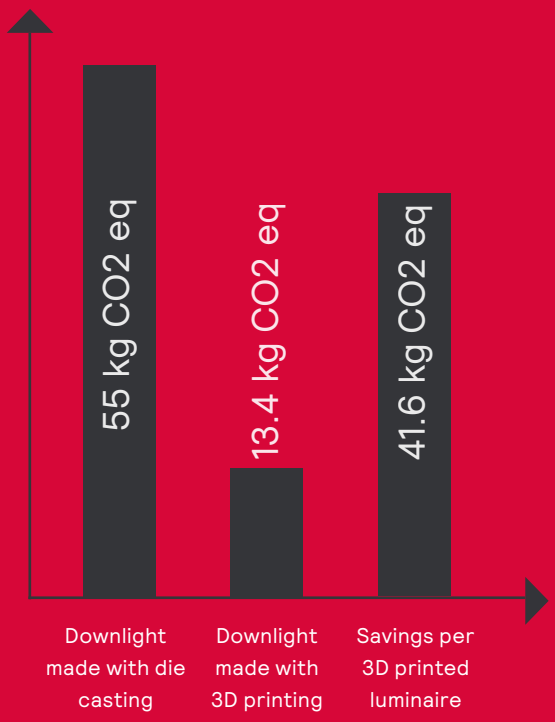
The following points were considered in the study:

- all components (excluding packaging)
- type of components
- material of components
- weight of components
- manufacturing method of components
- component supplier location
- mode of transport

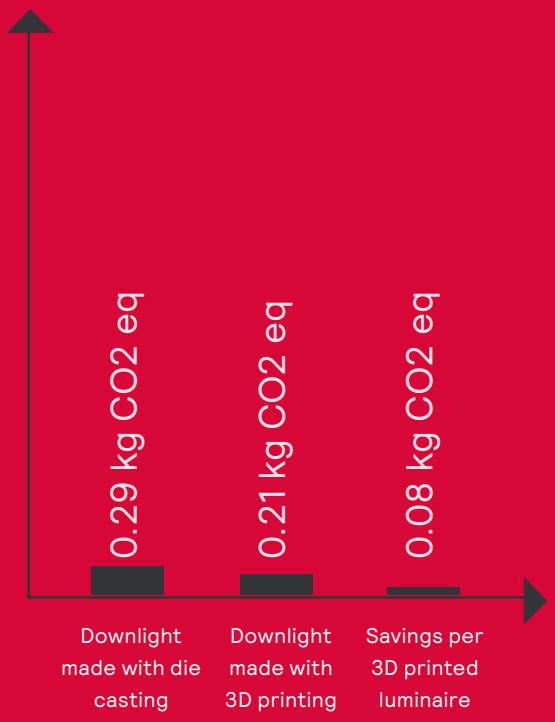
The impressive result of the study showed significant savings of up to 76% in material supply and manufacturing and up to 28% in transportation.

Eliminating die casting for housings is critical to reducing carbon emissions because a lot of heat is required to create the metal housings. The avoidance of metal housings also helps to decrease emissions for transport by reducing the luminaire's weight by more than 20% – a critical factor when transporting products.

## Absolute Carbon Emissions and Savings in Materials Supply and Manufacturing




## Absolute Carbon Emissions and Savings in Transport



# Reducing carbon emissions in production

Signify is committed to reducing absolute greenhouse gas emissions by 90% and reaching net zero emissions by 2040. 3D printing plays a role in Signify's Climate Transition Plan, which sets out the roadmap to net-zero.

Increasing the use of 3D printing of plastic components (using recycled plastic) is part of Signify's initiative to accelerate product circularity, zero waste and clean transport.

The action to increase reuse and recycling is supported by increasing 3D printing of lighting products, based on recycled plastics and other bio-circular material.

Our ambition is to become truly circular in our 3D printing activities. We are deeply committed to reducing $CO_2$ emissions as a vital part of our efforts to combat climate change.

We print local and produce on-demand with short production lead times to prevent unsold stock, and we are proud to use 100% renewable electricity in our operations.

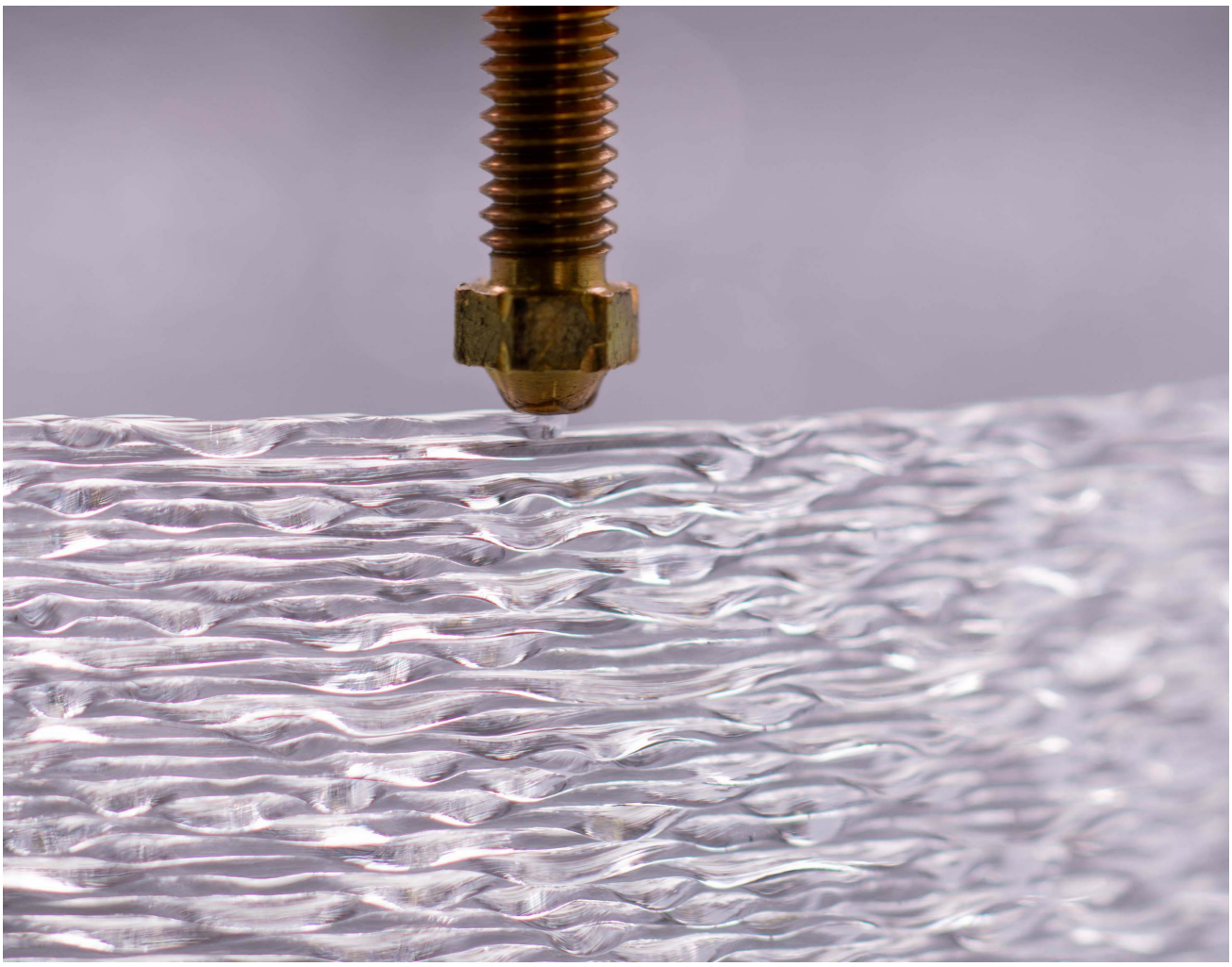
Our products are also lightweight, resulting in a lower carbon footprint associated with manufacturing, shipping and transportation.

# Producing on demand instead of on stock

Environmental aspects play an important role in reducing global warming – lowering $CO_2$ emission rates is one of the goals in designing a sustainable supply chain. A big step toward supply chain sustainability is the minimization of inventory, as warehousing has the potential for product waste and harmful greenhouse gas emissions. Since 3D printed luminaires are produced only on demand, there is no need to stock finished goods.

## From Make-to-Stock to Make-to-Order

Make-to-Stock (MTS) is a manufacturing method based on forecasted product demand. Once manufactured, products are kept in stock until they are sold. The alternative is called Make-to-Order (MTO) and starts production only after receipt of a confirmed customer order. This allows consumers to purchase products that are customized to their specifications. No inventory of finished goods is required, as only non 3D printed parts such as drivers or LEDs need to be stored – being able to use them for different products.



# Zero waste production

There is only one thing better than recycling waste: producing no waste at all. That is why we are actively investing in our “Towards Zero Production Waste” program. We are working to improve yields at all our production sites.

# Resulting in Sustainable products

Our 3D printed lighting products are designed for circularity and thus follow the “reduce-reuse-recycle” approach. Being energy-efficient and having a long product lifetime, our offerings are not only environmentally friendly but also cost-effective.

## Energy efficiency and lifetime

Our products are highly energy efficient as we use advanced LED drivers, LED modules, and LED light sources from Signify.

The energy efficiency of our products can vary depending on the product series, ranging from 100 to 180 lm/W. Our lamp-based products vary depending on the customer’s choice of lamp and fixture type. We prioritize energy efficiency in our designs because energy consumption is the largest part of Life Cycle Assessments (LCA) for luminaires. In addition to energy efficiency, our products have a long and reliable lifetime of 50,000 to 100,000 hours.

We strive to provide products that are not only energy efficient but also durable and reliable, hence our 3D printed luminaires are part of the GreenSwitch program and are aligned with the Lighting for Circularity approach of Signify.

## Connectable

Our lighting products can connect with multiple lighting management and (building) automation systems. We have wired and wireless solutions. A majority of our products are Signify Interact ready. All of our connected solutions are either certified or at least comply with international communication standards such as Zigbee, Wi-Fi, DALI, and Bluetooth.

## Reusable & recyclable

The material for our printed parts is plastic. All printed parts are reusable and recyclable. We use no paint, no potting, no glue, and fewer screws for easy disassembly and to simplify recyclability. We cooperate with Colgate Paper/AIT, a well-recognized US-based recycling company for end-of-life management. For more details on reuse and recycling see “Pilot projects to close the loop” section.

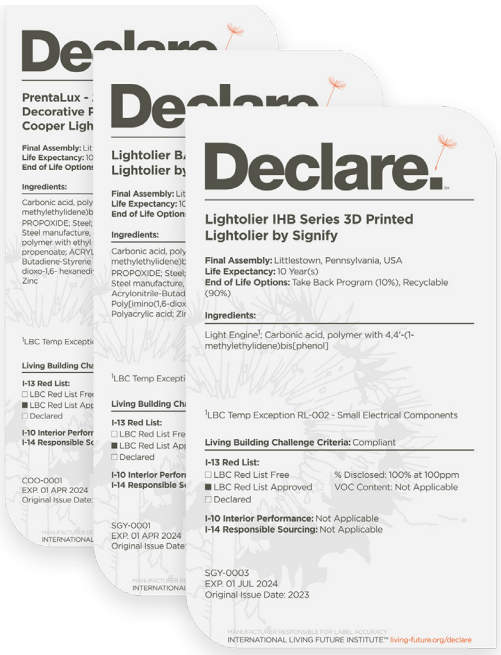
## Less weight

In comparison to traditional die-casting processes, many of our components are now printed significantly lighter in weight. We achieve up to 76% less carbon emissions in material sourcing and manufacturing, and we save up to 28% carbon emissions in transport compared to the traditional process. The lightweight nature of our products also simplifies the installation process.

## Declare certifications

To support the application of our products in green building certification programs, we made Declare certifications available for certain North American product series.

Declare is a nutrition label for building products from the International Living Future Institute. It is a platform where manufacturers voluntarily disclose product information on easy-to-read labels via a free database, to support requirements of leading green building standards, including the Core Green Building, LBC, LEED, and WELL Certifications.



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