



The lighter way of glass packaging: How to reduce weight to save material and energy

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Introduction: The Ecodesign Principles for sustainable product packaging solutions

The volume of global packaging is steadily increasing and with it the negative impact on the environment. On the same time, consumers become more and more conscious about the impact of their buying decisions. The transition to a circular economy is of essential importance. Improving the environmental impact of products throughout their whole life cycle - including production, transport, use and disposal must be the objective.

Packaging product solutions play a crucial role for the safe transport as well as storage, but also influence on the differentiation and attraction at the point of sale. To ensure that the environmental impact is considered from the beginning, the packaging design must be included already in the early development stage of a new product:

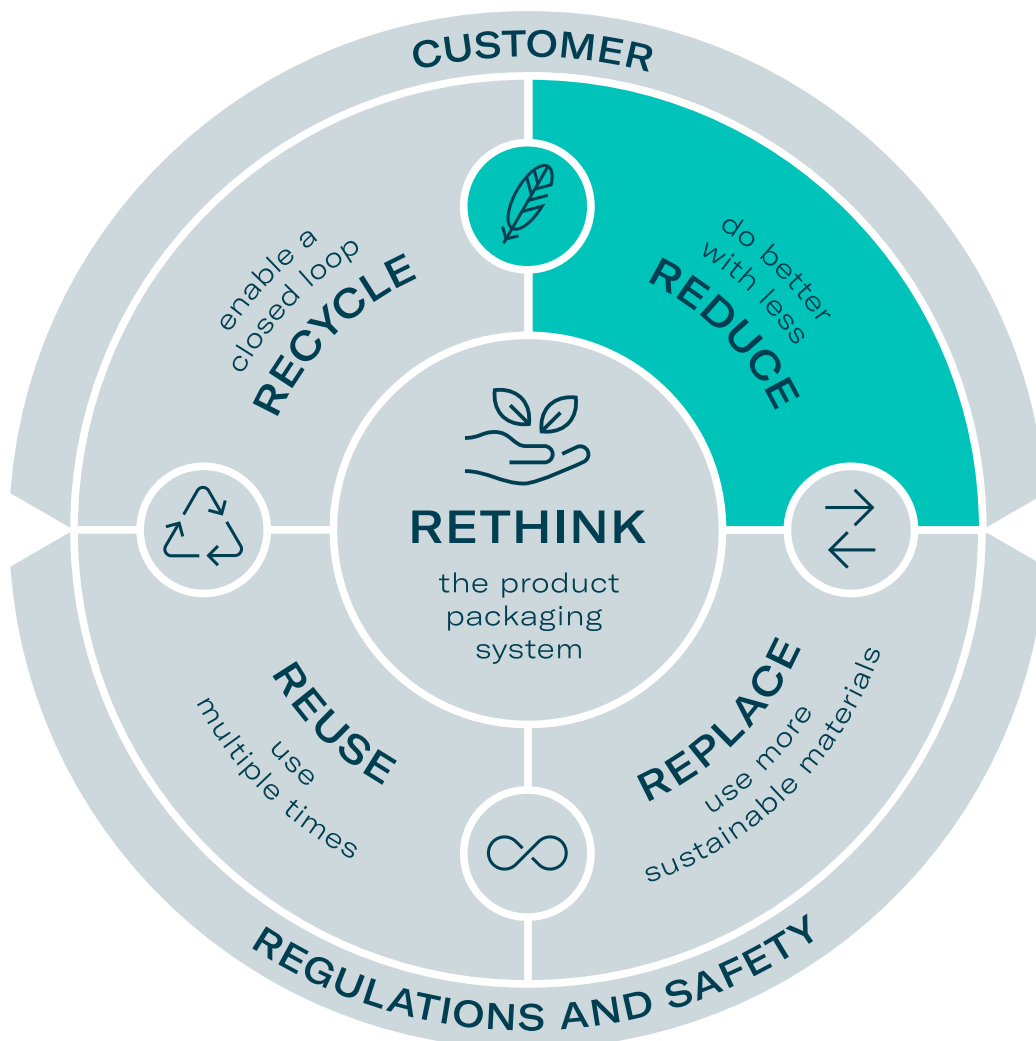


Figure 1: Ecodesign principles at Gerresheimer

Lightweight glass: A step forward to more sustainable packaging

Lightweight is one of the key Ecodesign approaches that can be classified into the category “Reduce – do better with less”. With reducing the weight of the glass packaging, influence is taken both on reducing material and energy.

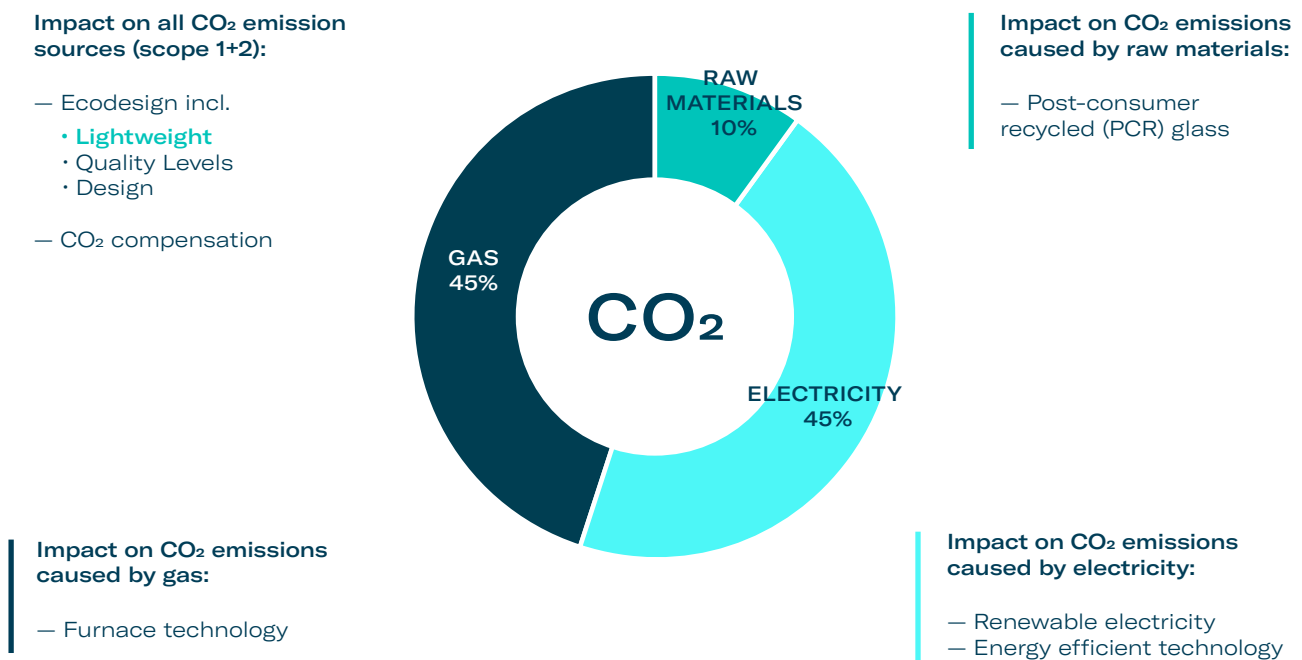


Figure 2: Key decarbonization approaches

About 90% of the CO₂-emissions in glass productions are caused by gas and electricity, while around 10% are from raw material used.

Most approaches to decarbonization tackle on specific emission sources, for example the use of renewable electricity cuts on the CO₂-emissions from electricity. Lightweight, however, addresses all emission sources at the same time. The less glass you use, the less raw materials are needed, the less energy (gas as well as electricity) is used to melt those raw materials.

Lightweight is a joint approach between brand and glass manufacturer. The approach requires close cooperation in the early development stage to successfully combine design and performance criteria. Of course, the approach can also be applied to optimize existing products. However, the design might limit the reduction potential.

Therefore, lightweight can be considered as one of the core measures on the decarbonization roadmap:

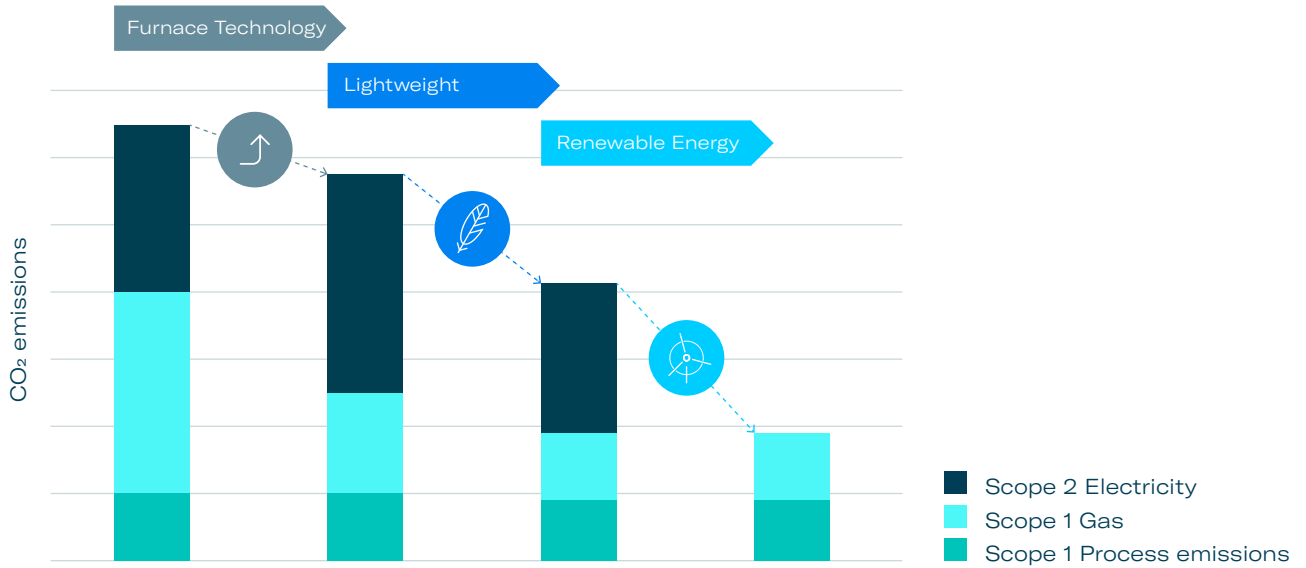


Figure 3: Example of a decarbonization roadmap



The positive impacts of lightweight glass packaging

Another point to mention is, that whereas many sustainability approaches require additional costs, lightweight can also be considered as a cost saving measure, as it can reduce the transportation and handling costs.

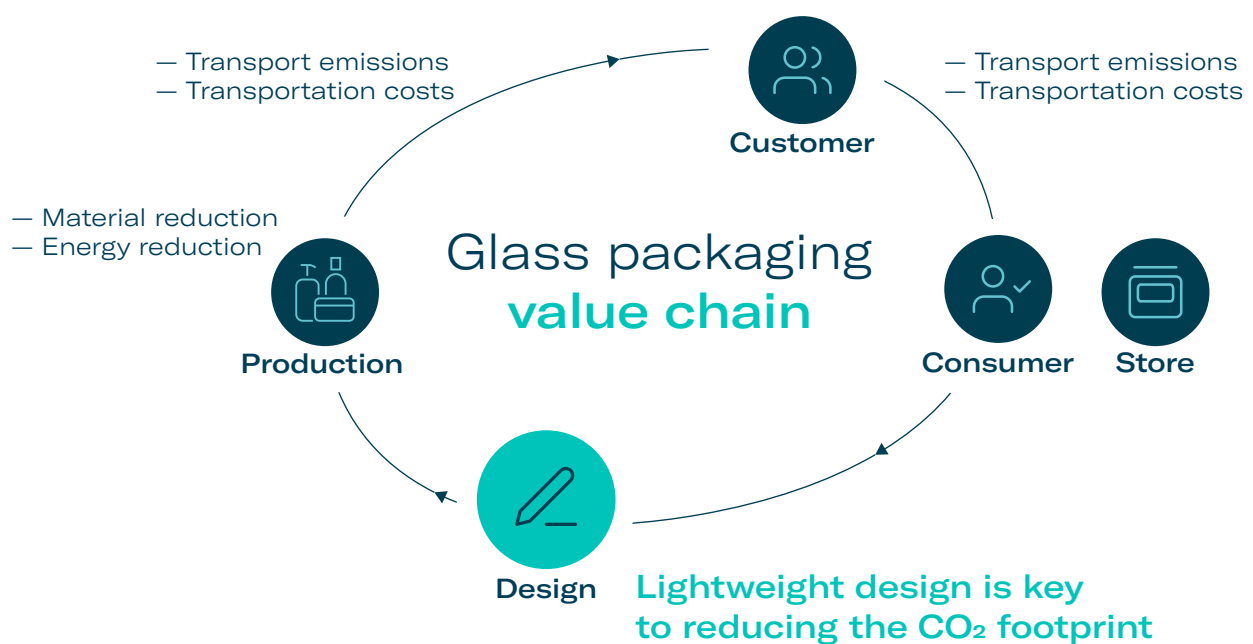


Figure 4: Positive impact of lightweight glass packaging

- Lightweight is a key decarbonization measure that is addressing all emissions sources at the same time
- Lightweight is a sustainability approach where the brand can directly influence the CO₂ footprint through the design
- Lightweight can have a positive impact on transportation and handling costs

Implications of lightweight on the product design

Lightweight is a joint approach between brand and glass manufacturer. The approach requires close cooperation in the early development stage to align the desired brand design, capacity, filling requisites and stability.

When considering a lightweight solution for a glass packaging, first the weight of the container needs to be determined. The glass weight for a moulded glass product is defined in the following formula:

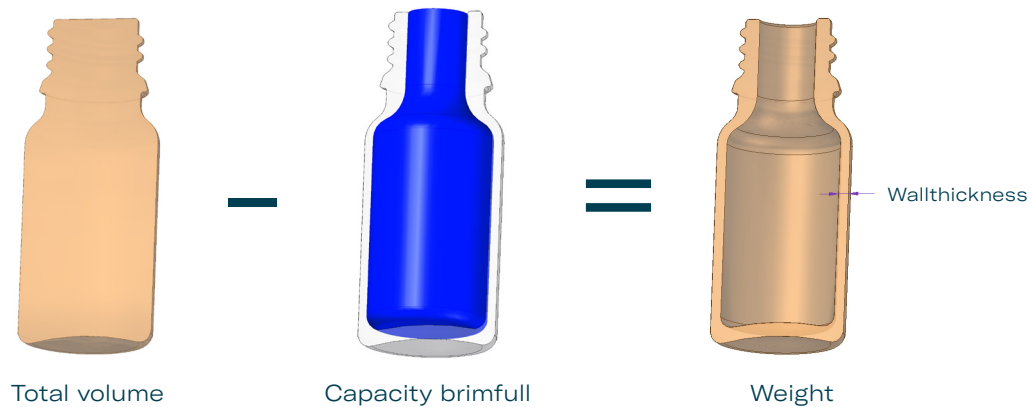


Figure 5: Glass weight calculation

Respecting the calculation formula, it becomes clear that if a glass packaging is changed to more lightweight, this decision has a significant influence on the product design. As a fact, the glass wall thickness is always a function given by the parameters total volume and capacity brimfull.

Conversely, the parameters which can be changed are total volume and capacity brimfull.



Parameters

The total volume is linked to the outer glass dimensions or geometry parameters. These parameters are directly influencing on the volume of the defined geometry and are clustered in different areas:

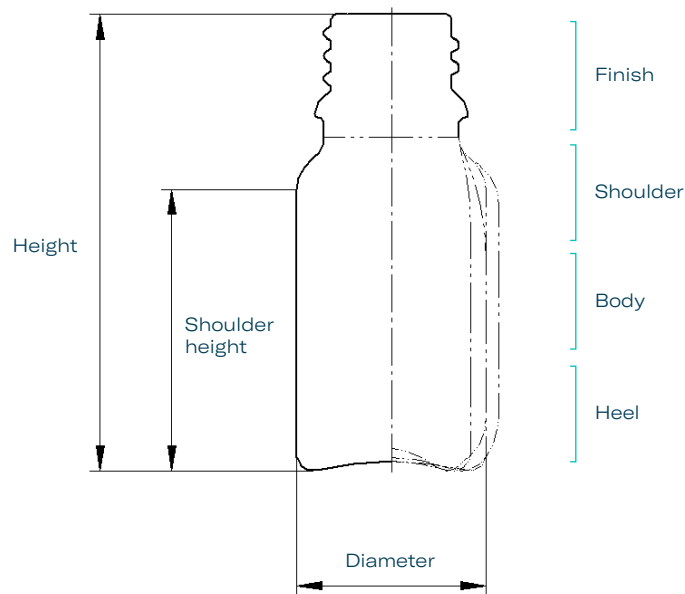


Figure 6: Geometry parameters

The design parameter capacity brimfull is linked to the needed headspace of the specific filling product and is defined by standards such as ISO, EN, DIN or CETIE. This means a change of the capacity brimfull is often not easily possible.



Wall thickness analysis

By rendering an existing product lighter, one of the parameters needs to be changed. As an example, the total volume can be reduced by changing heel, body and shoulder geometry. By doing so the specification of an existing article will change.

When the first design is drafted, there is always one question: Is the glass design strong enough to resist the system requirements? Or: How to know that the designed wall thickness is strong enough to avoid glass breakage?

Wall thickness

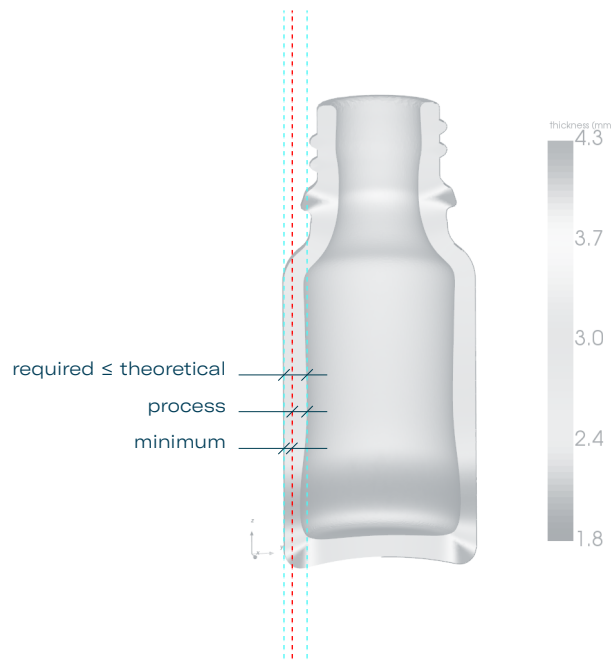


Figure 7: Specific wall thickness

To validate the wall thickness for lightweight, the required wall thickness needs to be smaller or equal to the theoretical wall thickness.

$$\text{wallthickness}_{\text{required}} \leq \text{wallthickness}_{\text{theoretical}}$$

The required wall thickness is a function of the manufacturing process and the mechanical resistance.

$$\text{wallthickness}_{\text{required}} = \text{process}_{\text{factor}} + \text{minimum}_{\text{factor}}$$

Minimum factor

The minimum factor is linked to the design of a moulded glass product, which needs to fulfill several requirements. These requirements are given by its end use and the value chain. The so-called system requirements are linked to:

- Product safety
- Glass type
- Filling product (e.g., carbonized)
- Closure requirements to fit on glass
- Surface requirements for labelling needs
- Filling line requirements such as line transport, filling, capping, thermal processing (e.g., pasteurization, hot filling, sterilization, freeze-drying, etc.), labelling, decorating, packing
- Logistic transport processes (e.g., by truck, see or air freight)

Based on the requirements, the mechanical forces, also known as loads, can be defined.

By knowing the requirements finite element analysis can be done to identify stress levels at the glass surface. The minimum factor is a result of the stress analysis.

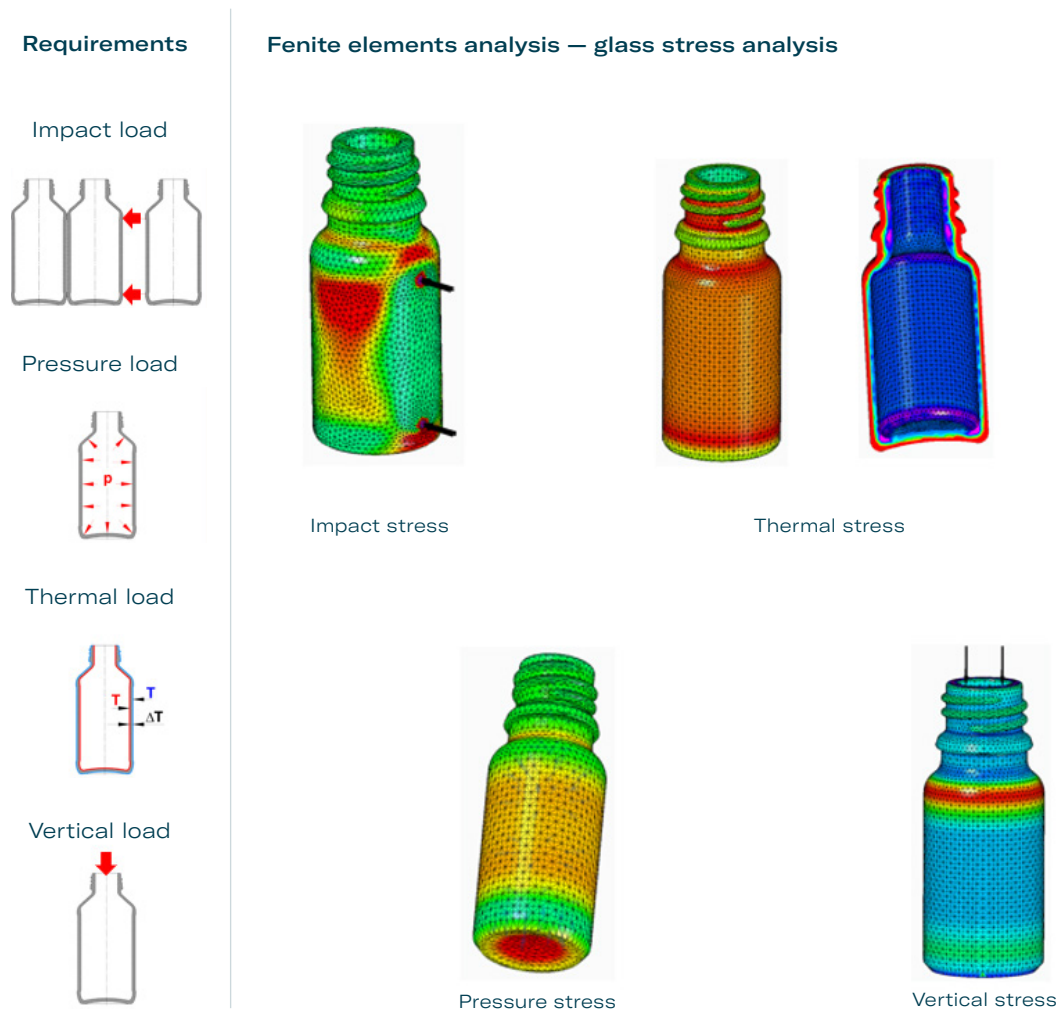


Figure 8: Requirements and stress analysis

Process factor

The process factor is linked to the forming process and mould engineering.

The container glass manufacturing uses two forming techniques: The press-blow and the blow-blow process. Both forming techniques are two-step processes, firstly a pre-forming and secondly a final forming step.

If you would like to learn more about the different glass forming processes, please get in contact with us.

In comparison to blow-blow, the press-blow shows less deviation in the process. This is caused by a more engineered process, thanks to the pressing plunger and shorter glass to mould contact times.

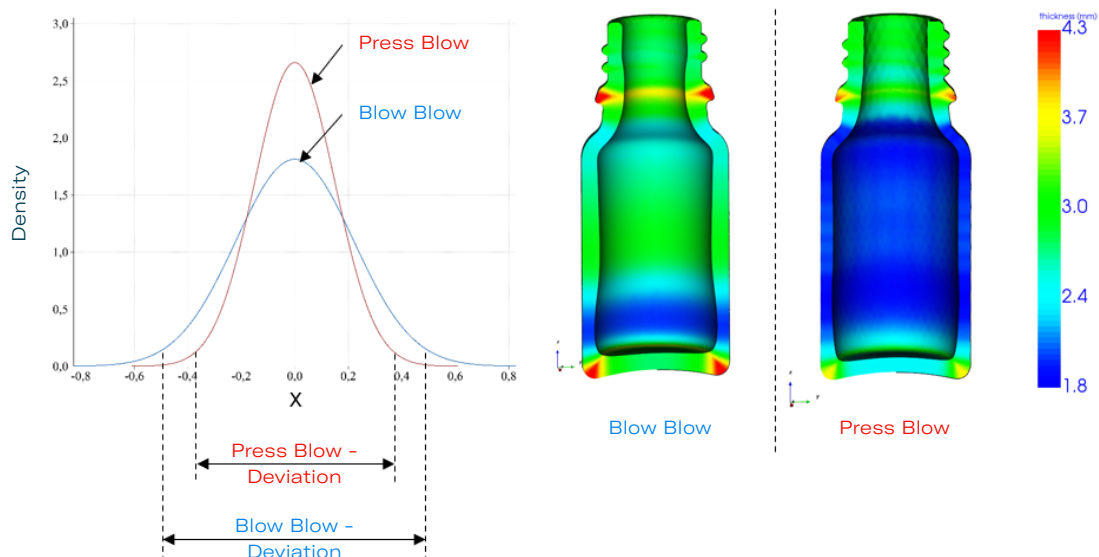


Figure 9: Press-blow vs. blow-blow process

Figure 9 shows a direct comparison of the process deviation between press-blow and blow-blow. It is clearly visible that press-blow has a significant smaller process deviation. Consequently, the press-blow manufacturing technique enables to reduce the needed process wall-thickness, because of the more stable process. The reason is linked to the glass wall-thickness distribution. In comparison to blow-blow, in press-blow significantly more homogeneous wall thickness distribution is possible.

In a nutshell: Taking the parameters and requirements into account from the beginning when developing the packaging design, allows for successful lightweight solutions.



Outlook and key take-aways

Whereas lightweight is currently considered as proactive approach, this might change in the next time: The packaging and packaging waste directive is currently under revision of the EU (European Union) (within the EU Green Deal) and might impose additional requirements on glass to improve the sustainability performance.

This means, whereas currently lightweight can be communicated as additional sustainability effort, in the future this might be a legal requirement.

- Lightweight is one of the most relevant decarbonization measures with the highest impact
- Lightweight is one of the most cost-effective sustainability approaches and even might generate cost savings
- Lightweight is currently voluntary, but could be legally required soon

Our Gerresheimer lightweight expertise

Our experienced teams are willing to join forces with you to develop designs that foster your brand's identity and turn products into a real masterpiece. We can support you in every step of the product development process with our expertise in design and technical knowledge.

At Gerresheimer we are continuously improving our manufacturing processes. By using new methods for engineering and manufacturing, we can reduce the deviation in our processes for now and for the future in order to assure the most homogenous wall thickness. Especially during the process development, we can simulate the complete forming process to achieve best results for lightweight designs right from the beginning.

We can be your sparring partner for idea generation, creative design, sustainability assessment and of course the technical evaluation of your project. We will bring the design to life!

Contact



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