The European glass sector contribution to a climate neutral economy

Position paper v.2

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In the context of urgent action to reduce carbon emissions and to meet the Paris Agreement, the European Commission launched an unprecedented strategy to cut Europe's emissions: the *European Green Deal*. Glass Alliance Europe welcomes the long-term vision and wishes to inform the decisions to be taken on the EU industry's contribution to the EU climate neutrality objective. Glass Alliance Europe stresses that, to be successful, the transition to a climate neutral economy needs a competitive EU industrial basis at the forefront of low-carbon solutions. Consequently, Glass Alliance Europe urges the European Commission to set a decarbonisation pathway that safeguards industrial competitiveness and good functioning of the EU internal market.

The glass industrial sector will be key to enable the implementation of the future decarbonisation strategy, because of its applications in sectors[1] with the highest emissions reduction potential (i.e. energy, building and transport) and the environmental advantages of glass. Given its role and the importance of its products, the European glass sector has consistently conducted heavy investments to manufacture glass products fit for a sustainable, resource-efficient, low-carbon and culturally vibrant European society.

Although industrial actions will be decisive, it is the EU political approach which will provide the enabling framework for this industrial revolution. It is thus fundamental that the future strategy addresses in a holistic and coherent way all relevant aspects, such as the infrastructure needs, the technological options available, the protection of the EU industry competitiveness, and fit-for-purpose trade policy. In the end, to be successful, the future EU decarbonisation pathway will need to be attractive to both industry and consumers.

1. A key enabling material for the transition to a carbon neutral Europe

The glass industry produces innovative, stylish and sustainable products which are present in every aspects of our daily lives. **Glass is a key enabling material for a carbon neutral Europe and its industry aims to remain at the forefront of low-carbon solutions in the European Union**:

- By **recycling** 74% of the bottles and jars put on the EU market, the glass industry saves about 9 million tonnes of CO_2 every year[2] and is at the forefront of the circular economy since decades;
- **Energy efficient** glazing and windows present a huge capacity to increase the energy performances of buildings, to reduce emissions, and to empower EU citizens to save energy and expenses;
- Continuous filament glass fibers enable the (road, rail and air) transport sectors to meet the low-carbon economy requirements providing **lighter and durable** composite materials;

[1] See Annex II "Glass industry value-chain".

[2] Based on FEVE LCA showing that 1 tonne of recycled glass saves about 580 kg CO_2 in the whole value chain.

- Glass is the main component of photovoltaic panels in weight[3] and glass fiber fabrics are the main/essential material for wind turbine blades. These supply alternative and **sustainable sources of energy and contribute to the growth of renewable energy in the EU**;
- As indicated by the European Commission, the long-term strategy largely relies on innovation and R&D. In this sense, the whole glass industry **continues innovating** in solutions which will unlock additional potentials for emissions' savings in the future (e.g. BIPV windows and switchable glass).

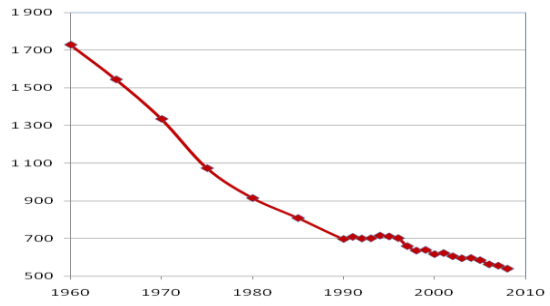
It is Glass Alliance Europe strong belief that a carbon-neutral Europe in 2050 needs a thriving glass manufacturing industry at the forefront of innovation in sustainable low-carbon glass solutions.

2. CO_2 emissions savings in glass manufacturing

Reduction of emissions in the Glass sector

The glass industry sector has invested in the decarbonisation of its manufacturing processes. For enabling the transition, the **glass sector has supported a balanced process that meets environmental protection**, always being aware of the **extremely competitive and dynamic context** where its industries operate.

Figure 1 – CO_2 emissions per tonne of glass output in France ($kgCO_2$/ tonne) - Source: France's Institut du Verre.



It stems from figure 1 (Source Institut du Verre)[4] that the glass industry has considerably decreased its emissions per output in the last 50 years (i.e. a reduction of 69% of CO_2 per tonne of melted glass). However, one can observe that additional reductions since 1990 are realised at a slower pace as marginal gains become more difficult.

Sources of CO_2 emissions in glass manufacturing are primarily high-temperature heat (between 1300 and 1500°C) from fuel combustion for melting (representing between 75 and 85% of the total CO_2 emissions) and process emissions from the decomposition of carbonates in the batch (between 15 and 25% of total CO_2 emissions[5]).

a) <u>High-temperature heat emissions</u>

The energy consumption and reduction of emissions have been intrinsically linked in the glass sector since fossil fuel is used to heat the furnace. Consequently, the rate of improvement in reduction of heat emissions over the last decades has been directly dependent on the energy efficiency measures implemented by the industry.

The rate of improvement slowed as energy efficiencies approached their practical maximum values. The overall efficiency of installations in the sector nevertheless steadily improved with the **uptake of best available technologies and efficiency improvements which were found also in non-furnace process** areas which allowed the industry to sustain its overall energy improvement programme.

[3] Glass represents between 67 and 97% of the photovoltaic panel total weight.
[4] The figures present the reduction of emissions per tonne of melted glass in France which can be considered as a good illustration of the general trend in the sector in the European Union.
[5] The variation in the share of process emissions results from a number of parameters including the ratio of cullet in the batch.

Improvements include for instance the **greater use of recycled glass, waste heat recovery, and furnace design and construction**. Incremental improvements to glass furnace technologies alone, would not generate massive GHG emission reductions and fundamental research and development is of paramount importance to unlock new solutions for further reducing the sector's emissions.

The historical link between energy efficiency improvement and the reduction of heat emissions would cease if the industry can **access to carbon neutral energy sources** (e.g. biogas) **or** operate a **switch to electric melting** using decarbonised electricity (a technology **not available** at the moment to large furnaces – see Annex I).

b) Process emissions

Process emissions occur due to the decarbonisation of the carbonate raw material in the process input, mainly sodium carbonate Na_2CO_3, limestone $CaCO_3$ and dolomite $CaMg(CO_3)_2$. These **"process emissions" were reduced by lowering the virgin raw materials input and increasing the share of "cullet", i.e. recycled glass**, in the batch. The use of cullet has long been identified as critical for the glass industry. As highlighted in the previous point, it also contributes to reducing the energy needed to melt (and the related heat emissions).

Throughout the EU industry, **virtually all internally generated cullet is reused**. Recycling schemes have been set up to collect and recycle post-industrial or post-consumer glass waste, in particular in the container glass sector. However, all post-consumer glass is not yet recycled, thus offering additional savings potential (see Annex I)[6]. The glass industry is investigating with authorities, glass recyclers and other stakeholders how to make these additional sources of cullet available. Nevertheless, it should be noted that deep emission reduction in process emissions cannot be expected from an increase in cullet input since this route is limited by the maximum amounts of not yet recycled glass available every year in the EU.

Required cross-sectoral Research & Development (R&D) for further emissions' savings

Moving from theoretical potentials for emissions' savings, as contemplated for some of the technologies listed in the European Commission in-depth analysis supporting its communication "A Clean Planet for All" (COM(2018) 773), to industrial options will require both public and private efforts in the coming decades. The glass sector has already identified a number of domains where R&D efforts should be focused. Most of **these innovative technologies would be cross-sectoral and could enable transition in a number of industrial sectors**:

- The **electrification** of large-size furnaces with melting temperature above 1000°C;
- **R&D in process emissions** which cannot be reduced solely by energy-efficiency measures or energy switch;
- R&D in heat transfer for large-size furnaces and for **alternative carbon-neutral fuels**;
- R&D to investigate the possibility of **carbon capture** and storage (CCS), and carbon and capture utilization (CCU) on site.

It is worth to be noted that the development of these new solutions to reduce manufacturing emissions will not be sufficient. Their deployment will require substantial public investments, in particular in the infrastructures (e.g. biogas distribution, hydrogen network, carbon free electricity availability) as well as adaptations to the existing regulatory framework (e.g. compensation for indirect emissions costs).

[6] 26% of container glass and the majority of end-of-life building glass are not yet recycled.

3. Enabling framework for the industrial transition to a low-carbon economy

To Glass Alliance Europe views, the main challenge of the industrial transition will be to ensure that efforts to further reduce Greenhouse Gas (GHG) emissions do not harm the industry competitiveness and that EU made glass products remain attractive to consumers. Therefore, **Glass Alliance Europe calls on the development of an integrated European industrial strategy for supporting the transition and the uptake and affordability of glass products**, to overcome bottlenecks to decarbonisation of manufacturing processes and to ensure the profitability of the EU based glass industry.

Infrastructures

Glass sectors are characterized by long-term investment cycles which require stability and predictability.

Some of the potential options for reducing emissions in the glass industry (see Annex I) are directly dependent on infrastructure investments outside the remits of the companies. These include for instance:

- The **availability and affordability of carbon neutral feedstock in sufficient quality and quantities** for the manufacturing of the glass products[7];
- High voltage **networks**;
- Reliable transport and storage infrastructures for **hydrogen**;
- Supply and logistics chains for enhanced use of **biomass** resources, acknowledging that the activation of this potential is limited by the quantities of biogas required by the sector and the quantities available[8];
- **Waste management and recycling facilities** to unlock potentials for further glass recycling;
- The creation of an extensive transport and storage infrastructures for carbon capture and storage or usage (**CCS/CCU**).

The public and private investments required to provide these enabling infrastructures for the industrial transition are substantial. For a number of them, actions will have to be taken **urgently** by public authorities to serve the mid-century objective, considering **there is only one investment cycle left for most industries**.

Circular economy

The Glass industry as long identified the **use of recycled glass, i.e. cullet, in its processes as an effective way to reduce its emissions**. In the EU, **74% of container glass**, the first glass sector in tonnage, is recycled which saves approximately 9 million tonnes of CO_2 every year[9]. The use of recycled glass reduced the melting temperature and means less virgin raw materials during the manufacturing process and hence a reduction of the energy consumption and CO_2 emissions[10]. Additional CO_2 reduction can also be achieved by the use of mineral waste streams from other processes (e.g. carbonate-free slag from metal industry) to replace virgin material.

[7] The assessment of infrastructure needs for carbon neutral feedstock should include all relevant sectors (including other industrial sectors, automotive and building).
[8] The UK study on "Biomass in a low-carbon economy" predicts a max potential of 15% of UK energy demand by 2050 against 7% today.
[9] Based on FEVE LCA showing that 1 tonne of recycled glass saves about 580 kg CO_2 in the whole value chain.
[10] Glass BREF (2012)

Glass Alliance Europe agrees with the European Commission's that **circular economy must be a building block to the decarbonized EU future and the yet untapped potential for further recycling should be addressed**. In particular, end-of-life building glass remains a mostly unexploited resource for additional cullet and would require public authorities' actions. Also, addressing the 26% of container glass not yet recycled in the EU represent a big opportunity in terms of circularity and CO_2 savings. Beyond the investments in infrastructures, national/regional/local regulatory measures could be considered to close the loop such as enacting bans on landfill for recyclable waste, and promoting pre-demolition audits.

CAPEX-OPEX and competitiveness

The European Glass industry evolves in a competitive international environment with **high exposure to international trade and competing materials**. One of the principal **challenge** EU based companies will face is to **remain competitive while continuing investing in low-carbon technology**.

Companies' profitability is dependent on the CAPEX and OPEX, in particular for most glass products which are "commodity-like products". The implementation of new technologies or use of alternative carbon-neutral energy will have an impact on these two indicators. **Some of the potential options** for reducing the manufacturing emissions (see section – manufacturing) **could result in substantially higher operating costs which would need to be mitigated to guarantee EU products remain competitive**.

Several **concrete actions** would be required from the EU to maintain the affordability and attractiveness of EU made glass products to the consumers:

- Secure international level playing field for European industrial sectors and a fair global market, always bearing in mind the evolving global trade and climate policy dynamics;
- As long as competing non-EU countries do not implement equivalent measures, a **full carbon leakage protection for both direct and indirect costs of the EU ETS is required to protect the sector's competitiveness on the internal and external markets**;
- Some European glass industries suffer from unfair international competition; e.g. dumping. The transition to low-CO_2 economy will be a high-risk operation and it is therefore essential that this process is accompanied with **effective EU protection mechanisms to swiftly address unfair trade practices**;
- **Reconsider state aid guidelines and regulations** to establish whether and how member states could implement production support for low-CO_2 production processes;
- **Improve information on existing EU funding schemes** by creating one stop shop website with information to plant operators.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Annex I : Technology potentials for further emissions savings

The glass industry is contemplating several more 'disruptive' routes for decarbonising its production process. **Not all the below technologies are mature, nor readily applicable to all branches of the glass industry. Most importantly, many of the below technologies are mutually exclusive**. Therefore, the theoretical emission reduction potentials cannot be added up.

Increased supply of good quality cullet

Almost all container and flat glass manufacturers have the potential to use more cullet (=recycled glass) on the condition that it is available at the right quality. This route to lower emissions is consistent with sustainability efforts in the industry and the EU Circular Economy aspirations however its potential is limited to the theoretical maximum of amounts of waste glass that is available every year in the EU (container glass is already highly recycled (74%) and waste building glass quantities not yet recycled are limited in the EU).

Use of waste heat to pre-heat raw materials (standard batch or pelletised batch)

Waste heat recovery is already extensively applied in the glass industry to preheat the combustion air entering the furnace at temperatures higher than 1,000°C. Some residual waste heat can be further used to preheat the raw materials entering the furnace or for other applications like district heating. Pre-heating the raw materials is limited to preheating of either cullet only or batches containing more than 40% cullet, otherwise clogging problems and dust carry-over would occur. This is why the necessity to increase the availability and affordability of good quality cullet (point above). The use of pelletised batch would remove this limitation and solve the issue of batch carry-over, which is often associated with the use of pre-heaters but is not yet mature. It must be noted that pre-heating raw materials cannot be coupled with electric melting, as the flue gas temperature in this case is too low.

Low carbon/hybrid combustion

This category encompasses in fact a number of different options some of which can be combined:

- Switch to almost full-electric (~80%) melting;
- Oxy-fuel combustion (and use of decarbonised electricity to produce the oxygen);
- Use of biogas, acknowledging that the activation of this potential is limited by the quantities of biogas required by the sector and the quantities available[11];
- The addition of carbon-free hydrogen to the gas grid. However, any alternative fuel (especially hydrogen) must be modified as hydrogen flames are much less luminous than natural gas flames, making the heat transfer to the glass melt much less efficient. This will still require quite some coordinated research. The efficiency of oxyfuel combustion can be improved by preheating of the gas and oxygen using the waste heat from the furnace.

It has to be noted that most of these technologies do not eliminate the CO_2 process emissions (originating from the decomposition of raw materials leading to CO_2 emissions and representing between 15% and 25% of the total glass industry's emissions).

[11] The UK study on "Biomass in a low-carbon economy" predicts a max potential of 15% of UK energy demand by 2050 against 7% today.

Full electric melting

A switch to all electric melting using decarbonised electricity would eliminate CO_2 emissions from glass melting which are generated from the combustion of fossil fuels. However promising this technology may be, its implementation is still limited today by the size of the installations, the glass composition, and the quantity of cullet contained in the batches[12].

Although electric melting is available for small furnaces (< 200 t/day), it still needs to be demonstrated for large furnaces used in flat or container glass production (from 200 to 1.000 t/day). For certain glass compositions (e.g. E-glass for continuous filament glass fibers) there are technical aspects (associated with the electrical conductivity) which limit the proportion of electrical energy for melting. Currently, there is no all-electric furnace for melting E-glass.

The cost of electricity, the quality of melting (especially with high levels of cullet) and the quality requirements of the final glass products are the main barriers to uptake and further innovation in this area. Moreover, the stability of the grid and the safety of electricity supply are also essential parameters to consider for glass melting since glass furnaces need permanent and stable energy feed and cannot operate intermittently depending on the availability of decarbonised electricity.

Carbon capture

Carbon capture is interesting to consider for addressing the process emissions (estimated between 15 and 25% of today's emissions) in glass manufacturing which cannot be avoided by an energy switch, provided carbon neutral energy is used for the CCS process. Nevertheless, CCS demands a number of barriers to be overcome to be considered as an option (today, it is limited to a theoretical potential only). Carbon capture and storage would require creating extensive transport and storage infrastructures for carbon capture and storage to be a large-scale solution by 2050. Taking into account that the industry is characterised by small, disseminated units mostly located in brownfields, the CCS/CCU options are limited due to first technical constraints (space limitations, presence of acidic compounds, low CO_2 concentration) and second the limited market demand for carbon.

[12] Full-electric melting for high cullet containing batches and reduced batches resulted in unstable batch and process behaviour and difficulties in reaching high specific pull rates due to hampered degassing of batch and glass.

Figure 2: Summary of technology potential for reduction of emissions in glass manufacturing

Category of potentials	Technology	TRL	CO_2 reduction[13]
CCS/CCU	Carbon capture	4	Max 90%
Fuel switch to carbon-neutral energy	Carbon neutral gas	8	75 to 85%
	Electric melting	9 (small furnaces) 5 (large furnaces[14] and specific glass type) 3 (continuous filament glass fibers)	75 to 85%
	Liquid biofuel	8	75 to 85%
	Hydrogen 20% in gas pipe	7	15 to 17%
	Hydrogen 100%	5	75 to 85%
Circular economy	Increased use of recycled glass (container)	9	Max 20%
	Increased use of recycled glass (flat)	9	Max 5%
Process	Batch pelletisation	6 to 8[15]	Max 5%
	Raw materials pre-heating	8	Max 15%
	Glass batch reformulation	4	Max 20%
Process	Waste heat recovery	9	Max 15%

These more 'disruptive' routes for decarbonising production process are not all mature, nor readily applicable to all branches of the glass industry. Most importantly, many of the below technologies are mutually exclusive. Therefore, the theoretical emission reduction potentials cannot be added up. In addition, their deployment will require substantial public investments, in particular in the infrastructures as well as adaptations to the existing regulatory framework.

[13] Please note that many of the below technologies are mutually exclusive and theoretical emission reduction potentials cannot be added up.

[14] It must be noted that the container glass and flat glass industries together represent over 85% of the EU glass production and emissions. They are precisely the two sectors with the largest-size furnaces (from 200 to 1000 tonnes of glass per day).

[15] The TRL varies from one glass type to another.

Annex II : Glass industry value-chain